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## The Battle of Hastings: A Geographic Perspective

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A thesis submitted in partial fulfillment of the requirements for the degree in Doctor of  
Philosophy  
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## Abstract

The Battle of Hastings (1066) is one of the most widely studied battles in medieval history. Yet despite the importance that research shows geography to play in the outcome of such conflicts, few studies have examined in detail the landscape of the battle or the role the landscape played in its eventual outcome. This study, consequently, seeks to assess the impact of geographic factors in understanding the events that shaped the Battle of Hastings. The analysis was undertaken using a geographic information system (GIS) with qualitative and quantitative techniques. Historical and current data combined in a series of detailed state of the art maps are used to bring an entirely new perspective to the nearly millennium long literature on the battle. Factors considered in the study included variables associated with mobilization of the respective armies, the topography and land use at the time of and since the battle, population, food/animal sources, metal resources, water, and the location of the battle. The final section of the thesis provides a detailed cartographic discussion of the development of the battle itself. Among the findings of this thesis were that location was indeed important in the mobilization of the armies, that the local topography has not changed significantly since the battle, that the distribution of resources available to the armies varied spatially, and perhaps most importantly, that there may exist at least one viable alternative battle site to that on Battle Hill.

## Keywords

Battle of Hastings, England, France, GIS, Landscape, Medieval Warfare, Spatial Analysis, Topography, William I

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Appendix B: Glossary..... 325

## Abbreviations and Units

<i>ANS</i>	<i>Anglo-Norman Studies</i> 1979 - Pres
<i>A-S</i>	Hall, J. R. (1960). <i>A Concise Anglo-Saxon Dictionary</i> (4th ed.). Cambridge: Cambridge University Press.
<i>ASC</i>	<i>The Anglo-Saxon Chronicle</i> (M. J. Swanton, Trans.). (1998). New York: Routledge.
<i>BA</i>	<i>The Chronicle of Battle Abbey</i> . (E. Searle, Trans.). (1980). Oxford: Oxford University Press.
<i>BH</i>	Rumble, A. R. (1996). An Edition and Translation of the Burghal Hidage, together with Recension C of the Tribal Hidage. In D. Hill, & A. R. Rumble (Eds.), <i>The Defense of Wessex: The Burghal Hidage and Anglo-Saxon Fortifications</i> (pp. 14-35). Manchester: Manchester University Press.
<i>BL</i>	<i>British Library</i>
<i>BM</i>	The Battle of Maldon. (1991). (D. Scragg, Trans., pp. 15-36). In D. Scragg (Ed.), <i>The Battle of Maldon, AD 991</i> . Oxford: Basil Blackwell, Inc.
<i>BR</i>	Brevis Relatio de Guillelmo nobilissimo comite Normannorum. In <i>Chronology, Conquest and Conflict in Medieval England</i> . (1997). (E. M. van Houts, Trans., Vol. 10, pp. 1-48). Cambridge: Camden Fifth Series.
<i>BT</i>	Stenton, F. M. (1965). <i>The Bayeux Tapestry: A Comprehensive Survey</i> (2nd ed.). London: Phaidon Press. Cited by plate.
<i>CEH</i>	<i>Centre for Ecology &amp; Hydrology</i>
<i>CHP</i>	<i>The Carmen de Hastingae Proelio of Guy, Bishop of Amiens</i> (2nd ed.). (1999). (F. Barlow, Trans.). Oxford: Clarendon Press.
<i>DB</i>	<i>Domesday Book</i> (Vol. 2 Sussex). (1976). (J. Morris, Trans.) Chichester: Phillimore & Co. Ltd.
<i>DHG</i>	Gregory, D., Johnston, R., Pratt, G., Watts, M. J., & Whatmore, S. (Eds.). (2009). <i>The Dictionary of Human Geography</i> (5 <sup>th</sup> Ed.). Chichester, UK: John Wiley & Sons Ltd.
<i>DMLBS</i>	Latham, R. E., Howlett, D. R., & Ashdowne, R. K. (Eds.). (1975-2013). <i>Dictionary of Medieval Latin from British Sources</i> . Oxford, UK: Oxford University Press. Cited by fascicle and page number.

- DOE* Cameron, A., Amos, A. C., & Healey, A. D. *et al.* (Eds.). (2007). *Dictionary of Old English: A to G* Online. Toronto: Dictionary of Old English Project.
- EHD I* Whitelock, D. (Ed.). (1996). *English Historical Documents, 500-1042* (2nd ed., Vol. I). London: Taylor & Francis.<sup>1</sup>
- EHD II* Douglas, D. C., & Greenaway, G. (Eds.). (1981). *English Historical Documents, 1042-1189* (2nd ed., Vol. II). London: Taylor & Francis.<sup>2</sup>
- ESHER* *East Sussex Historical Environmental Record*
- GND* *The Gesta Normannorum Ducum of William of Jumièges, Orderic Vitalis, and Robert of Torigni* (Vol. II). (1995). (E. M. C. Van Houts, Trans.). New York: Oxford University Press.
- GR* *Gesta Regum Anglorum: The History of the English Kings* (Vol. I). (1998). (R. A. Mynors, R. M. Thomson, & M. Winterbottom, Trans.). Oxford: Oxford University Press.
- HA* *Henry, Archdeacon of Huntingdon Historia Anglorum: The History of the English People*. (1996). (D. Greenway, Trans.) Oxford: Oxford University Press.
- JW* *The Chronicle of John of Worcester: The Annals from 450 to 1066* (Vol. II). (1995). (J. Bray, & P. McGurk, Trans.) Oxford: Clarendon Press.
- OED* *Oxford English Dictionary: The Definitive Record of the English Language*. Oxford University Press. (2015). Retrieved May 2015, from [www.oed.com](http://www.oed.com)
- OS* *Ordnance Survey of Great Britain*
- OV* *Historia Ecclesiastica* (Vol II). (1969). (M. Chibnall, Trans.). Oxford: Oxford University Press.
- RR* *The History of the Norman People: Wace's Roman de Rou.* (2004). (G. S. Burgess, & E. M. C. Van Houts, Trans.). Woodbridge, UK: Boydell Press.

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<sup>1</sup> This reference collection includes the ASC and the Battle of Maldon poem (*BM*). Other pre-1042 sources would be included here as well.

<sup>2</sup> This collection includes the “Rights and Ranks of the People” (*RSP*), the Bayeux Tapestry (*BT*) as well as excerpts from most of the other documents reproduced in Brown’s book (1995) and not in *EHD I*.



*SHLC – I* Bannister, N. R. (2010). *Sussex Historic Landscape Characterisation* (Vols. I -  
- V V). West Sussex County Council; East Sussex County Council; Brighton  
& Hove Unitary Authority; English Heritage.

*V. C. H.* *Victoria History of the Counties of England*. Cited by county and volume.

*VER* *The Life of King Edward who rests at Westminster*. (1962). (F. Barlow, Trans.).  
London: Thomas Nelson and Sons Ltd.

*WP* *The Gesta Guillelmi of William of Poitiers*. (1998). (R. H. C. Davis, &  
M.Chibnall, Trans.). Oxford: Clarendon Press.

All units unless indicated will be in *SI* format.

**Distance**

Meter (m)

Kilometer (km) – 1,000 m

**Field Measurements**

Acres, Roods, Perches (1 Statute Acre = 4 Roods and 1 Rood = 40 Perches)

**Area**

Square Meter (m<sup>2</sup>)

Hectare – 10,000 m<sup>2</sup>

Square Kilometer (km<sup>2</sup>) – 1,000,000 m<sup>2</sup>

**Volume**

Cubic Meter (m<sup>3</sup>)

Litre (L) – 1,000 m<sup>3</sup>

River Discharge (Q) (m<sup>3</sup>/s)

**Currency**

Pounds (£), shillings (s),<sup>3</sup> pence (d) – 1 £ = 20 s and 1 s = 12 d

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<sup>3</sup> Unless in combination with £ and d, (s) is a measurement of time.

# Chapter 1

## 1 Introduction

[T]o understand the people of [Medieval Europe] . . . and their experience [including warfare], it is . . . necessary to get to know the geographical, topographical, and material reality of their world. Geography is, to a great extent, Destiny (Bucholz & Key, 2004, p. 1).

Every soldier knows that geography is destiny. From the grandest of grand strategy to the smallest of small unit tactics, the “lay of the land” has always been a key factor in military operations (Stephenson, 2003, p. Front Flap).<sup>1</sup>

Despite this conventional wisdom, few historians have conducted comprehensive examinations of the role of geography in determining the outcome of wars conducted during the medieval period (Foard & Curry, 2013).<sup>2</sup> This contrasts markedly with the numerous studies that have relied on geographic analysis to understand the agricultural production of the time (Campbell, 2000; Brandon P. F., 1972; Campbell, 2007; Williamson, 2003; Williamson, 2013).

As a partial remedy to this deficiency, and following Bucholz and Key’s proposition, this study will seek to apply geographic analysis to an understanding of human history. Specifically, it uses geography the “science that deals with the earth and its life; *esp* the description of land, sea, air, and the distribution of plant and animal life including human beings and their industries” (Allen, 2002, p. 367) to reinterpret the historical events associated with one of the most notable battles of medieval times: the Battle of Hastings, fought in England in the year 1066. The Battle of Hastings was selected for this study

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<sup>1</sup> These quotations refer to environmental determinism. Environmental determinism is the idea “that human activities are controlled by the environment” (Knox, Marston, Imort, & Nash, 2013, p. 567). The environment is defined as “[t]he physical surroundings or conditions [human or natural] in which a person or other organism lives, develops, etc., or in which a thing exists; the external conditions in general affecting the life, existence, or properties of an organism or object” (*OED*, Environment).

<sup>2</sup> In fact, as Williamson has indicated several historians have ignored or dismissed the physical landscape as not relevant to the early medieval world in general (Williamson, 2013, pp. 2-5). The only other example of a study on medieval battlefields and the environment is Carman and Carman’s study, however it does not go into detail on any one battle as will be presented in this thesis (2006).

because: 1) it is one of the single most important events in British history as the last time Britain was successfully invaded by a foreign power; 2) there are numerous descriptive accounts—including contemporary observations—of the battle providing a significant source of data; and most importantly, 3) there are few detailed reconstructions of the battle and none that utilize geographic data or methods that assist us in understanding its ultimate outcome. This study thus fills a significant void in the existing literature from the past 1000 years.

In this introductory chapter, a review of the context and rationale for this study are presented. The research objectives and specific questions which will guide the study are also discussed along with a thorough outline of each subsequent chapter.

## 1.1 Background to the Battle

The Battle of Hastings was fought on October 14, 1066, just north of the town of Hastings. It was the result of a succession crisis to the English crown which pitted Duke William of Normandy against Harold Godwineson of Wessex. The battle was a decisive victory for William largely, it would seem, because so many of the English elite died in the battle, thus leaving a void in the English power structure.

There are a large number of sources which address this period in British history, as will be examined in Chapter 2 in significant detail. Contemporary sources for the battle include William of Poitiers' *Gesta Guillemi*, the *Anglo-Saxon Chronicle*, the Bayeux Tapestry, William of Jumièges' *Gesta Normannorum Ducum* and the *Carmen de Hastingae Proelio* (Morillo, 1996).<sup>3</sup> More recent interpretations of the battle are numerous, and include Lawson (2003), Bradbury (1998), the papers reprinted in Morillo's collection on the battle (1996) and Grehan & Mace's recent book on the event (2012; Huscroft, 2009). As a result, the Battle of Hastings is one of the most written about events in British history (Lawson, 2003, p. 16).

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<sup>3</sup> Each of these sources is reprinted in Morillo (1996), but the references will be to the published editions of the sources (See Chapter 2).

In addition to the purely historical accounts of the Battle of Hastings, there have also been a series of cartographic representations of the conflict. These depictions have been developed either for academic audiences or popular histories. The most respected academic depiction is by General E. Renouard James from 1909 (Brown R. A., 1996, pp. 198-9; Baring F. H., 1909).<sup>4</sup> This map has been reprinted in several key studies on the Battle of Hastings, such as the works of Brown (1996), Lawson (2003) and Wood (2009). The map also appears to be the basis for Morillo's maps of the Battle of Hastings in his edited work on the battle (1996, pp. xxiii-xxx). However, this map only depicts the topography of the local region and provides little information on land use.<sup>5</sup> Other cartographic representations are presented in Bradbury's work on the battle (1998, pp. 139-41). Lawson has reproduced Freeman's (2003, p. 139; Freeman, 1875) and Ramsay's (2003, p. Plate 36; Ramsey, 1898) maps of the battle. Additionally, there is the map by Howarth (2002) which has been reproduced and adapted by Grehan & Mace in their recent account of the conflict (2012, pp. 124-8). Similar to the James map, these cartographic representations present only the topography with limited land use information. Furthermore, with the exception of Morillo's maps, they only depict one or two stages of the battle. The Freeman map is the sole source that breaks down the armies into smaller units for a more effective depiction of unit placements and movements (Lawson, 2003, p. 139; Freeman, 1875; Morillo, 1996, pp. xxii-xxx). Overall then, while various maps have provided useful depictions of the battlefield and the starting locations of each of the armies, generally they fail to depict the distinct stages of the battle. This

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<sup>4</sup> This reference was originally published as Brown, R. A. (1980). The Battle of Hastings. *ANS*, III, 1-21. However in this study, the reference will be from a reprint: Brown, R. A. (1996). The Battle of Hastings. In S. Morillo, *The Battle of Hastings: Sources and Interpretations* (pp. 196-218). Woodbridge, UK: The Boydell Press. The study has also been reprinted as: Brown, R. A. (1992). The Battle of Hastings. In M. Strickland, *Anglo-Norman Warfare: Studies in Late Anglo-Saxon and Anglo-Norman Military Organization and Warfare* (pp. 128-42). Woodbridge, UK: The Boydell Press.

<sup>5</sup> The term topography itself means "[t]he detailed study and description of a place as much as to the materiality of its features or landforms more generally" (*DHG*, p. 762). However in this study, topography will follow the meaning of topographic maps which is "[a] map showing the three-dimensional nature of the terrain surface (elevations and landforms) as well as other ground features" (Kimerling, Buckley, Muehrcke, & Muehrcke, 2009, p. 473).

shortcoming seriously limits the possibility for any cartographic interpretation and analysis of the engagement.

The opposite is true of popular history depictions which appear to be developed with modern cartography in a geographic information system (GIS). They also do present the development of the battle through time (Morillo, 1996, pp. xxii-xxx; Gravett, 1992; Osprey Publishing, 2006), and therefore aid in enhancing our understanding of the event. However, they present a purely artistic depiction of the battle and there is little or no evidence about how they were developed (Gravett, 1992; Osprey Publishing, 2006; Gregory & Ell, 2007). All in all then, such analysis has been limited, and in general is not viewed as an effective research tool (Kimerling, Buckley, Muehrcke, & Muehrcke, 2009; Gregory & Ell, 2007).

## 1.2 Statement of Problem

Similarly, few, if any studies have included or entertained a detailed analysis of the landscape of the battle. The term landscape can take on many different meanings. To a geographer, landscape “refer[s] to both the visual appearance of land, most often countryside, and its pictorial depiction via perspective techniques for representing depth and space” (*DHG*, p. 409). On the other hand, to one prominent archaeologist, the term can apply to “products of human efforts, combined with natural features of the terrain, which together give certain regions a distinctive character” (Pryor, 2010, p. 5).

The *Dictionary of Human Geography* breaks the landscape down into the natural and cultural landscape. The natural landscape is considered as all elements of the landscape which are naturally occurring i.e. living (wild animals, birds and vegetation) and non-living (topography, soil and streams). These phenomena are typically explored through the branch of geography known as physical geography.<sup>6</sup> The cultural or human landscape, on the other hand, is “a landscape modified by the effects of human activity [or] . . . a notional landscape which embodies the cultural or artistic features of a country”

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<sup>6</sup> Physical geography is “[t]he characterization and explanation of geological, hydrological, biological and atmospheric phenomena and their interactions at, or near the Earth’s surface” (*DHG*, p. 531).

(*OED*, Cultural; *DHG*, pp. 133-4)<sup>7</sup> and is explored with human geography.<sup>8</sup> This definition contrasts with the concept of environment, which as defined on page 1 is “[t]he physical surroundings or conditions [human or natural] in which a person or other organism lives, develops, etc., or in which a thing exists; the external conditions in general affecting the life, existence, or properties of an organism or object” (*OED*, Environment).

Regardless of perspective, however, virtually all studies of the Battle of Hastings to date have explored landscape simply as an illustrative extension of the written sources as opposed to considering the historic landscape “as a source itself and as a means of integrating other evidence” (Rippon, 2004, p. 3).

This concept of considering landscape in the first instance, and as a mechanism for integrating and reinterpreting existing written sources is important because the battle was fought at a location which could have impacted the army commanders’ decisions. Fortunately, much is known about the medieval landscape from land uses, the *Domesday Book*, and crop yield records (Campbell, 2000; Campbell, 2007; Brandon P. F., 1972; Rippon, 2004; Cantor, 1982; Roberts, 1987; Rowley, 1982; Williams M. , 1982), thus, facilitating a new and more comprehensive approach to understanding the battle than has been undertaken in the past.

In pursuit of this new approach, this project seeks to re-examine the course and outcome of the Battle of Hastings using the landscape as the focal point of the investigation, following a series research questions presented in Section 1.5. Relying on the full potential of current mapping and map-based analytical techniques, it will provide: 1) more detailed and advanced cartographic depictions of the battle; and 2) a more comprehensive understanding of the role of the landscape in determining the outcome of the battle. The analysis will include a detailed discussion of how maps in support of

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<sup>7</sup> Figure on p. 134 of the *DHG* explains the differences between a cultural and natural landscape.

<sup>8</sup> Human geography “is centrally concerned with the ways in which place, space and [the] environment are both the condition and in part the consequence of human activities” (*DHG*, p. 350).

these objectives were developed, and which sources were employed in their creation. Specific sources will include the historical records, as well as numerous environmental sources, as presented in Table 1.1 which provides a comprehensive listing of each including the associated abbreviation, date, place and brief description.

The project will contribute significantly to the existing literature for two primary reasons. The first is that it will present a detailed and localized<sup>9</sup> example of how the natural / cultural landscape can be relevant to the medieval period (Williamson, 2013, pp. 2-5). This outcome will further academic geography / history because it demonstrates how the landscape as a source can be studied by historians. The second relates to accessibility and reliability to informed audiences. The Battle of Hastings is one of the most important events in British history and much has been written about it from an academic perspective. Its history has also been widely accessible to a wider audience. Such popular history, however, tends to be visual in nature, whereas academic history is based upon text (Gravett, 1992; Lawson, 2003). This study combines the best of both, and is based upon both visualization and text. Thus, this project will fill a void by being both accessible to a wider, informed audience and, given the extensive detail it brings to our understanding of the battle, a novel and reliable source of information for future research.

**Table 1.1: Table of Sources**

	Source	Year	Location	Description
English	<i>ASC</i>	Yearly since 9 <sup>th</sup> century	Various	Provides an account year by year since the late ninth century until the mid-twelfth century (Swanton, 1998, pp. xviii-xxvii).
	<i>BM</i>	Early 11 <sup>th</sup> century	England	An account of a battle fought at Maldon “against the Vikings in August 991” (Brown, 1995, p. 93).
	<i>VER</i>	1065-7	England	This document consists of a “history of Edward the Confessor’s reign . . . and . . . a religious life of the dead king” (Brown, 1995, p. 80).

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<sup>9</sup> This study is specific to a certain area as opposed to a more general study over a broader area.

Norman	<i>CHP</i>	1066-8?	Amiens?	The <i>Carmen</i> “was written by an educated person, with plenty of biblical and classical references. It . . . [is believed to be the] poem about the Battle of Hastings by Guy, Bishop of Amiens” (Bradbury, 1998, p. 116).
	<i>GND</i>	1070 – 1	Jumièges	The <i>GND</i> “is almost certainly the earliest of the Norman literary sources . . . [i]ts author . . . was a member of . . . abbey of Jumièges, which was a prestigious ducal foundation . . . in Upper Normandy” (Brown, 1995, pp. 1-2).
	<i>WP</i>	1070’s	Norman Court	Poitiers’ biography of William “is arguably the most important . . . for the invasion and campaign of 1066. It was written by a well informed, well connected and very well educated contemporary in the 1070’s” (Brown, 1995, p. 15).

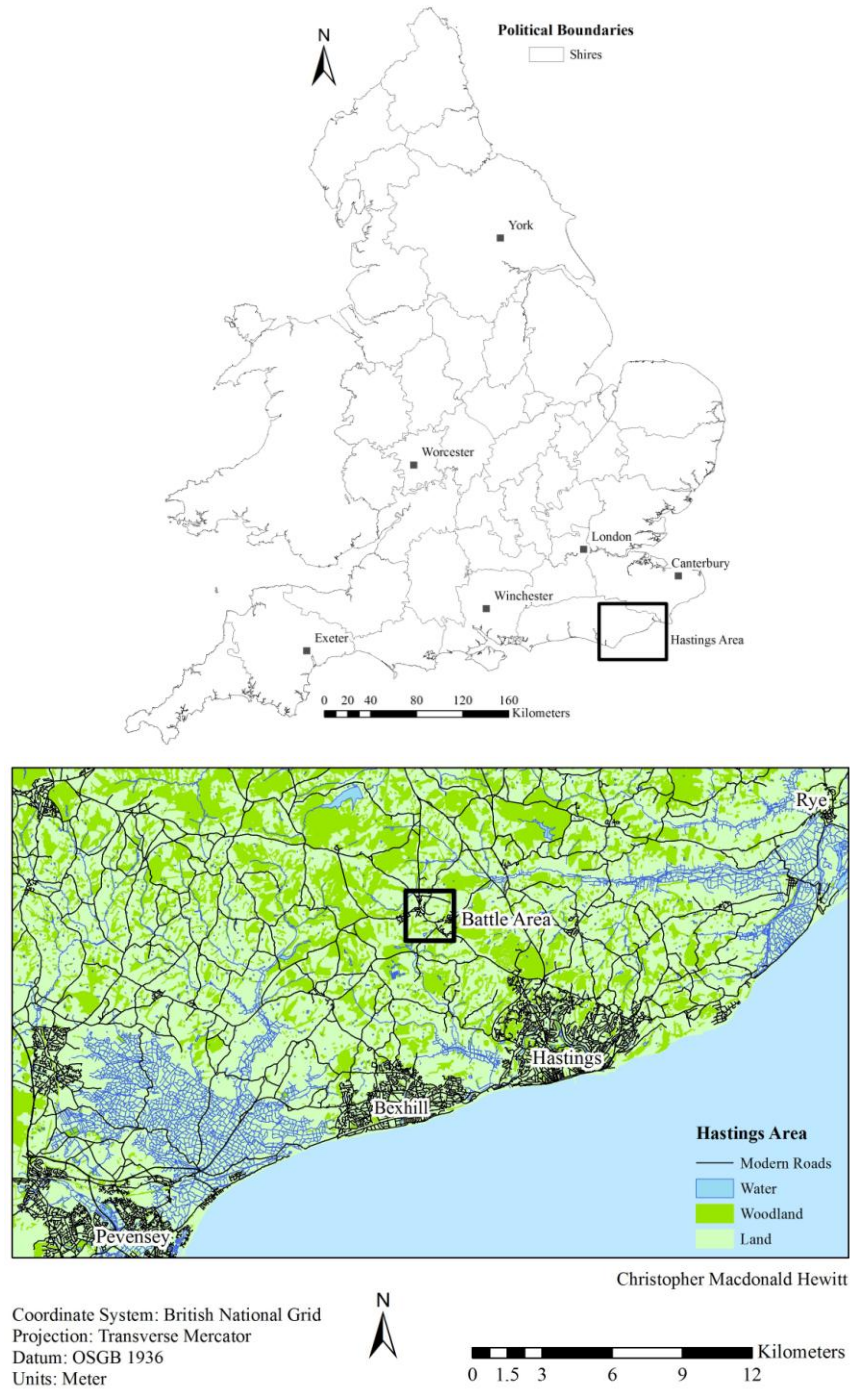


Anglo-Norman	<i>GR</i>	Early 12 <sup>th</sup> Century	Malmesbury Abbey	William wrote “carefully planned histories based on wide research and seeking to reach the unbiased truth” (Brown, 1995, p. 114).
	<i>JW</i>	Early 12 <sup>th</sup> Century	Worcester	“The work was begun at Worcester . . . and continued as a contemporary history down to c. 1140 . . . Since his historical method was to copy . . . relevant passages . . . it looks . . . as though John or Florence used a version of the Chronicle now lost” (Brown, 1995, p. 52).
	<i>OV</i>	Early 12 <sup>th</sup> Century	St. Evroult Monastery	“No one, it might be said . . . knew the Anglo-Norman world as he did . . . researching . . . all the extent histories he could find . . . and the charters and archives of his own house and others, as well as collecting oral testimony” (Brown, 1995, pp. 98-99).
	<i>BR</i>	Early 12 <sup>th</sup> Century	Battle, Sussex	Discusses “Normandy and England from about 1035 to the early twelfth century” (Lawson, 2003, p. 112).
	<i>HA</i>	Early 12 <sup>th</sup> Century	Huntingdon	Henry was an archdeacon at Huntingdon and his work, <i>Historia Anglorum</i> was widely known and copied (Bradbury, 1998, p. 119).
	<i>BA</i>	12 <sup>th</sup> Century	Battle, Sussex	The chronicle is “two . . . anonymous chronicles of St Martin’s [abbey] at Battle . . . Both date from the last third of the twelfth century” (Brown, 1995, p. 121).
	<i>RR</i>	12 <sup>th</sup> Century	Normandy	Examines “the deeds of the Norman dukes from the earliest, the tenth century Rollo, down to the battle of Tinchebrai” (Lawson, 2003, p. 114).
	<i>DB</i>	1085-86	Across England	A survey by King William in “each shire to enquire in great detail about its resources and who held them” (Darby, 1977, p. 3).
Admin		11 <sup>th</sup> Century	England and Normandy	Laws and customs indicate how society including military obligations functioned at the time.
Artistic	<i>BT</i>	1070’s	Kent, England	The Bayeux Tapestry is a “famous stretch of embroidery [which] . . . has been regarded as one of the principle authorities [on] . . . the Norman Conquest of England” (Stenton, 1965, p. 9).

Cartographic		Various	England and Normandy	Multiple historical maps were considered in this project from the fourteenth to eighteenth century (Appendix A).
	<i>OS</i>	Various	England	Ordnance Survey of Great Britain maps includes roads, rivers, and topography or a digital elevation model (DEM) (Ordnance Survey, 2012).
	<i>ESHER</i>	Various	East Sussex	The historic environmental record of East Sussex (East Sussex County Council, 2013; SHLC - I, 2010; SHLC - II, 2010).
		1851	England and Wales	A GIS dataset of the Parishes of England and Wales from 1851 (Burton, Westwood, & Carter, 2004).
		2009	Battle, Sussex	The point elevation data is a high resolution look at the Battle area.
Environmental		1200 – 1500	Southern England	Crop yield data is derived from “surviving medieval manorial accounts . . . [which] contain all the information . . . [to calculate] the yields of specific crops . . . in dated years” (Campbell, 2007).
		Various	Sussex	Iron sites across Sussex indicate local metal resources as well as possible habitation sites.
		781 – 2009	East Anglia	Precipitation datasets are “millennial length precipitation reconstructions for . . . England” (Wilson, et al., 2012).
		Various	Sussex	“The soil erodibility factor <i>K</i> indicates a soil’s inherent susceptibility to erosion” (Brady & Weil, 2004, p. 527).
	<i>CEH</i>	1969 – 2011	Hastings	Hydrologic measurements (precipitation and river discharge) in the Hastings area (CEH, 2013).

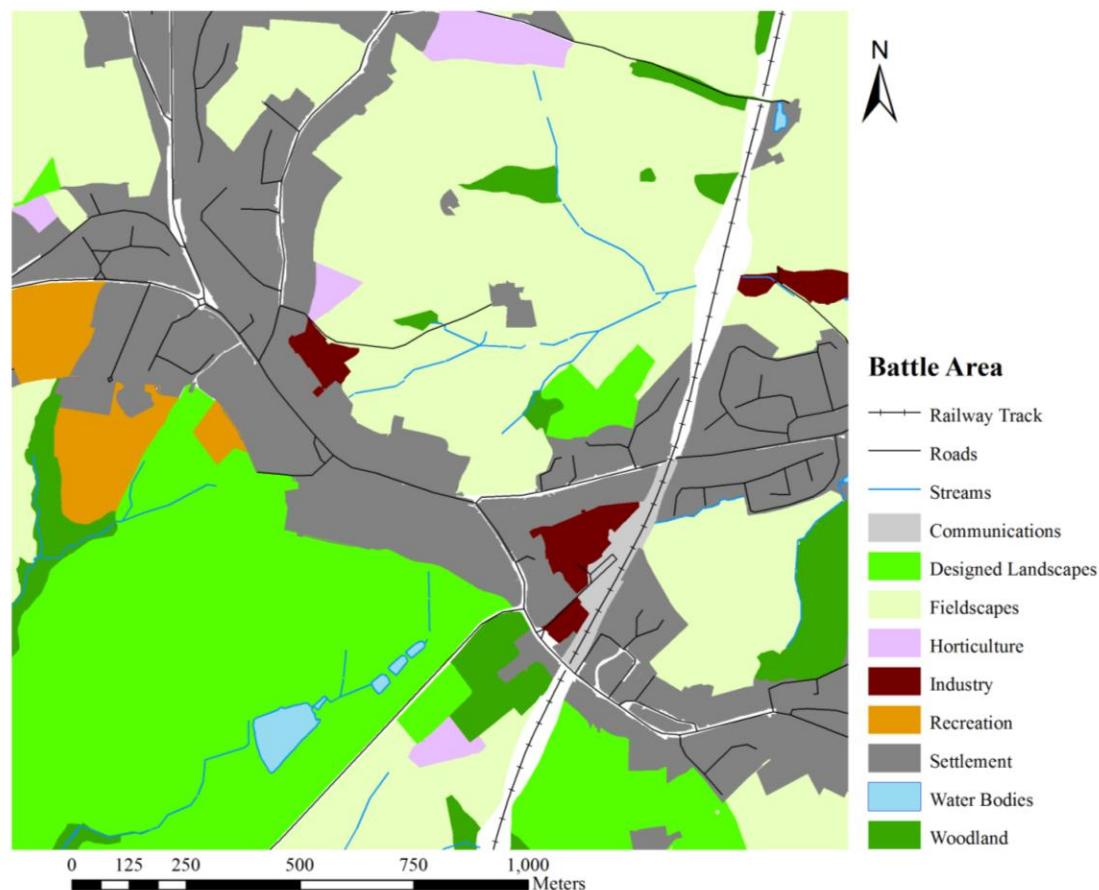
### 1.3 Definition of Study Area

The area to be examined in the project is that surrounding the town of Battle in East Sussex, generally considered to have been a peninsula in the medieval period (Gravett, 1992, pp. 50-1). Specifically, the Hastings area extends from Pevensey to Rye and up to and slightly beyond the town of Battle. For a map of the Hastings area, see Figure 1.1 which includes a box for the Battle area specifically (Historic Counties Trust, 2010; Ordnance Survey, 2012). Figure 1.2 presents the land uses of the modern Battle area (ESHER, 2013; Ordnance Survey, 2012).



**Figure 1.1: Location Map (2010) and Present Day Hastings Area (2012) with Local Roads, Rivers and Woodland<sup>10</sup>**

<sup>10</sup> Sources for these maps are the Historic Counties Trust (2010) and the Ordnance Survey (2012).



**Figure 1.2: Present Day Battle Area with Detailed Land Uses (2013), Local Rail, Roads, and Streams (2012)<sup>11</sup>**

## 1.4 Social Context

Given the focus of this study on the Battle of Hastings and the role of geography in determining its course and outcome, it is important to understand the social context in which the battle took place and in which it was first described in the literature. This social context is medieval society. As it existed in the eleventh century, this society was characterized by a fundamental relationship between three social orders. These were the

<sup>11</sup> Sources for these maps come from the East Sussex Historic Environmental Record (ESHER) (2013) and the Ordnance Survey (2012).

clerics (monks, schoolmen and secular churchmen), warriors<sup>12</sup> and workers (peasants). These orders were in existence in England from the time of King Alfred in the late ninth century (Abels, 1988, p. 66 and 132). This structure is detailed in an article by Powell (1994), who elsewhere presents a copy of the document from the ninth century from which it has been derived (1994, pp. 103-4). The same social structure can also be witnessed in pre-eleventh century France (Powell, 1994, p. 106). According to Powell, Duby claimed that the Three Orders were “a response to a specific political crisis of early eleventh century western Francia . . . [where t]he ‘warrior class’ had turned their attention to plundering the ‘civilian’ population and were out of control” (Powell, 1994, p. 129).<sup>13</sup> Therefore, the idea of this social structure was present on both sides of the channel leading up to 1066.

The first group, the clerics, were the religious and learned men of society. They were literate and including the monks, schoolmen and secular churchmen wrote many of the sources in this study (Clanchy, 2013, pp. 114-5). Among the second group, the fighting men of society, the most recognizable warrior of the middle ages was the mounted knight. Regarding knights, as one textbook put it,

[f]or all the . . . [modern] images that . . . surround the medieval knight, he was, in essence, an armed thug. Mounted on a charger and clad in helmet and chain mail, he was the medieval equivalent of the modern tank . . . Fighting was what he had been trained for; it was the chief justification for his existence; and it was how he grew wealthy . . . Knights claimed that they protected Church and society, and they sometimes did. But knights were violent men, primarily interested in defending and extending their own estates (Bennett & Hollister, 2006, p. 180).

The final or third group was the workers or peasantry. Peasants tended the fields and supported the two previous orders. They also would have worked to support the armies in the Hastings area. The peasant experience throughout the thirteenth to fifteenth

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<sup>12</sup> This term includes all types of soldiers from landless (no estate) professionals to the nobility (from minor knights to the great land holders).

<sup>13</sup> An extensive analysis of this concept has been presented by Duby in *The Three Orders: Feudal Society Imagined* (1980).

centuries with respect to the “land use, production, productivity and commercialization” of agriculture is described in Campbell’s book on the subject (2000, p. 25). Campbell indicates that England, up until about 1300, was dependent on small scale agriculture for food and trade (2000, p. 437).

Taken together, these three social orders constituted what is known as feudal society. Feudalism<sup>14</sup> developed from the disintegration of power following the reign of Charlemagne’s son, Louis, in the early mid-ninth century (Bennett & Hollister, 2006, pp. 133-5).<sup>15</sup> As it existed in Carolingian France (Barlow, 1988, p. 7), feudalism centered on the main residence, or *caput* (usually a castle) of a major land lord and its honour court where the vassals would perform homage (Chibnall, 1986, p. 2). It was this system which existed in Normandy prior to 1066 (Chibnall, 1986, p. 2). More specifically, feudalism was:

a personal bond between two free men – a superior (the lord) and an inferior (the vassal) – and a method of land tenure, whereby the vassal held a benefice of his lord. The personal relationship, deriving from an act of commendation, the putting oneself under the protection, the ‘mund’ of a lord, appears in all Germanic societies and was fully present in England . . . [The relationship was ritualized through] a ceremony in which the vassal, on his knees, placed his hands between those of his lord’s and swore an oath of fealty . . . [and in exchange] the lord . . . [would] protect and maintain the man (Barlow, 1988, p. 7).

From the military perspective, the microcosm of feudalism may be seen as “a soldier serving a defined (and usually limited) term of service in exchange for possession of a fief, a landed estate [or manor] which provides him with his support” (Morillo, 1994, p. 6).<sup>16</sup> The concept of feudalism has been widely employed to explain how the elite

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<sup>14</sup> The term “Feudalism” comes from the seventeenth century and thus some historians argue that it may not be applicable to the medieval period (Chibnall, 1986, p. 2; Barlow, 1988, p. 7; Bennett & Hollister, 2006, p. 135).

<sup>15</sup> Louis the Pious’ sons, Lothar, Louis the German and Charles the Bald “rebelled openly against him and plunged the Empire into civil war” (Bennett & Hollister, 2006, p. 121).

<sup>16</sup> The term “feudalism derives from *feudum*, [which is] the Latin term for fief” (Bennett & Hollister, 2006, p. 136). The fief was “the units of knightly tenure owing more or less standardized services from which

governed “the social and political structures” of the people (Bennett & Hollister, 2006, p. 135). Feudal customs in this regard varied between countries. For example, in Normandy restricted warfare was permitted between nobles but considered as treason in England (Stenton, 1932, p. 13).

Medieval European society was also characterized by manorialism. Manorialism governed “the economic structures [of society] . . . whereby the landowning elite were supported by the peasantry” (Bennett & Hollister, 2006, p. 135). This institution began to develop in the eighth century and was common practice by the eleventh (Bennett & Hollister, 2006, p. 104 and 162). The manor “was a block of landed property managed as a single unit from a particular centre” (Miller & Hatcher, 1978, p. 19). In most instances there was one manor per village. However, in some cases a village consisted of multiple manors. Conversely, some manors were spread over multiple villages. The organization of these manors also varied with some split between the lord’s demesne and the tenants, while others were solely demesne or tenants.<sup>17</sup> Therefore, “the manorial framework” was a complex variable system which was “superimposed” on the local settlements (Miller & Hatcher, 1978, pp. 19-20). This concept complements feudalism because feudalism was the political structure while the manor was the economic structure.

These concepts are important for this project because the Battle of Hastings took place during the eleventh century in a medieval society centered upon the feudal manor and the inter-relationship between the three social orders. Therefore, prior knowledge can assist in helping to understand the context of the battle as well as the sources used in this study and the audience for which they were written. It can also aid in the selection of an appropriate method of analysis, and in better understanding the motivations of the key actors.

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later theorists derived the name” (Chibnall, 1986, p. 2). Other definitions of the term can be located in DeVries and Smith’s book on military technology (2012, pp. 99-101).

<sup>17</sup> The demesne was “land that an owner held back for direct use, as opposed to land dispersed to tenants” (Bennett & Hollister, 2006, pp. G-3).

## 1.5 Research Approach and Questions

This study employs both qualitative and quantitative approaches to the study of an historical event that focus on a fundamental geographic tool: mapping. These techniques were derived from several aspects of academic geography. Insofar as geography focuses on both the natural and cultural elements of the landscape, both were included to ensure a well-rounded and detailed study.

The primary research question is: How can Historical GIS (HGIS) contribute to our knowledge of the natural and cultural landscape in 1066 and its influence on the development and outcome of the Battle of Hastings? This question was explored in detail in this thesis through an investigation of a series of specific inquiries. These are:

1. What can HGIS contribute to our understanding of the geopolitical state of England and northern France<sup>18</sup> in the eleventh century?
2. How can HGIS inform us about the natural landscape, precipitation and climate of the Hastings area and how they have changed since the battle?
3. What resources (e.g. animals, food, industry, and water) were available to the English and Norman armies?
4. What can HGIS reveal about the potential locations of the battle and which is the most likely?
5. How did the natural landscape influence the development and outcome of the battle?

## 1.6 Data Acquisition

From an historical perspective, sources are seen as falling into two broad categories: *primary* and *secondary* (Rampolla, 2004, p. 5). Primary sources were written around the

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<sup>18</sup> Northern France includes Normandy, Brittany, Flanders and the Île-de-France among other regions.



time of the event in 1066, whereas secondary sources are the interpretations of the event by later historians following an historical method (Northey & Knight, 2005; Rampolla, 2004; Howell & Prevenier, 2001, pp. 70-1).<sup>19</sup> However, in geography, primary sources are data obtained directly from the environment while secondary data are interpretations of the environment (Northey & Knight, 2005, pp. 4-5).

For use in this study, data of all types were acquired from numerous sources. These sources range from the time of the battle until the modern era. They included the *Anglo-Saxon Chronicle*, *Domesday Book* and William of Poitiers' *Gesta Guillelmi*. The two most accessible collections are Brown (1995) and, specifically for the battle, Morillo (1996). More comprehensive collections are in *English Historical Documents* Volume I (1996), II (1981), and van Houts's selection (2000). The published individual translations of the medieval sources are listed above in the abbreviations section. The sources have also been grouped by perspective and type as is displayed in Table 1.1. Additionally, some sources are to be found in digital form, such as the English translation of the *Domesday Book* which can be accessed online or in-print (Kings College, London, 2010; Morris, 1976; Palmer, 2010).

## 1.7 Analysis

As part of the study's geographic orientation (see page 1 for a definition of geography), the analysis of this project was conducted within a Geographic Information System (GIS).<sup>20</sup> GIS represents the world in either raster data or vector data (Bolstad, 2005; Gregory & Ell, 2007). This distinction is important because how GIS represents the data can have an impact on the types of analysis subsequently conducted. It can also influence the interpretation of these analyses. In this project, both GIS raster and vector data, as

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<sup>19</sup> See Chapter 3. For further discussion, see the method as discussed by Howell & Prevenier (2001, pp. 70-1). Rampolla's pocket guide is also useful as an introduction to historical methods (2004, pp. 5-22).

<sup>20</sup> A GIS is a "[c]omputer-based system to aid in the collection, maintenance, storage, analysis, output, and distribution of spatial data and information" (Bolstad, 2005, p. 1). A GIS also "combines a database management system (DBMS) with a computer mapping system" (Gregory & Ell, 2007, p. 3).

explained further in Chapter 3, were employed based on the subject and analytical context.

For their part, locational variables in England and northern France were explored through a series of maps developed specifically for this thesis, depicting land ownership, military service, political boundaries, roads, towns, and woodland. The mobilization for both the English and Norman armies was evaluated through a cartographic multi-criteria decision analysis (MCDA) model and a qualitative selection analysis both of which are explained in Chapter 3.

The environment of the Battle region itself is explored through a number of techniques. Climate is discussed through a development of novel graphs, correlation statistics and discussions of historical records. The local land uses were graphically represented for the study area over the last 1000 years. A land use map was also developed exclusively for the eleventh century at the time of the Battle, reconstructed through a process termed “map regression” (Rippon, 2004, p. 79). This process begins with modern maps of a location and then proceeds back in time through a transposition of older and older maps. The land use map was also developed using data from the East Sussex Historic Environmental Record (ESHER) as well as evidence contained in the *DB* and place-names (ESHER, 2013; King, 1962; Mawer, Stenton, & Gover, 1930).

The changes to the local topography were also considered, including the development of Battle Abbey and the amount of sediment which was potentially removed from the landscape in its construction (Hare, 1980). The Revised Universal Soil Loss Equation (RUSLE) examined the general amount of soil loss for the study area and battle site over the millennium since the battle. This analysis was conducted as a cartographic model.

The resources of the armies were determined from the detailed reconstructed land use map. These resources included food, timber and metals (Brandon P. , 1974). The crop yields for the fields were estimated from techniques presented by Campbell (2000, p. 397). Industrial resources were included from additional maps and the *DB* (King, 1962).

The location of the battle (Grehan & Mace, 2012) was assessed by a MCDA.<sup>21</sup> Similar to the armies and the landscape change, this analysis was conducted through cartographic modeling. Ultimately, several new and detailed maps of the battle and landscape were produced for this study.

## 1.8 Limitations

Each chapter of this study focuses on a specific research question or questions and contains its own unique assumptions and limitations which are discussed therein. However, there are several limitations which apply to the entire study. One limitation is that the contemporary sources for the battle were not analyzed in the original due to linguistic barriers, i.e. their use of Latin (Lilley K. D., 2011, pp. 149-50). Nevertheless, it must be emphasized that the focus of the project was not on reinterpreting the original sources, but rather in examining the landscape per se. Sources in translation were more than adequate for this purpose.

The second limitation comes from the data and how the landscape is represented on a map. In an historical mapping exercise such as this study, correcting for ambiguity or uncertainty can influence the subsequent analysis and interpretation. For example, in Chapters 5 and 6, classification judgments often had to be made in the development of the land use maps in the absence of detailed evidence from the period. As is discussed in the conclusion, this leaves the study findings in some respects open to debate.

## 1.9 Chapter Outline

The thesis is structured as follows. The present chapter consists of an overview of the social, political and geographic context of the study, an introduction to the research problem, presentation of the specific research questions, and how they will be pursued. In Chapter 2, the scholarly context for the study is examined through a comprehensive review of the sources and literature relevant to this project. Chapter 3 presents the

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<sup>21</sup> Several possible locations exist as mentioned by Grehan and Mace (2012) but the two main ones are either Battle Hill or Caulbec Hill (Grehan & Mace, 2012, pp. 124-128; Bradbury, 1998, pp. 132-135).

various methods of analysis applicable to the type of research undertaken including a justification of the methods employed in the thesis.

Chapters 4 to 7 address the specific research questions presented in Section 1.5. Chapter 4 will address research question 1, examining the political situation in England and northern France in the eleventh century. Specifically, it examines regional geopolitics in the English and northern French contexts as well as an overview of the economy and population as relevant to the mobilization of the respective armies at the Battle of Hastings.

Chapter 5 investigates research question 2. It seeks to understand the landscape, precipitation and climatic conditions of the time through an historical analysis of the likely changes that have occurred since the battle. Consideration of these factors is essential to understanding the outcome of the battle.

In Chapter 6 research question 3 will be examined. The thesis employs a geographic analysis of the resources available to the English and Norman armies at the time of the battle. The analysis includes the access to food, water and industrially produced implements.

Chapter 7 will explore questions 4 and 5. Using comprehensive mapping methods, the chapter focuses on potential sites of the battle thus contributing directly to current debates on this issue. Geographic analysis is utilized to follow the course of the battle during the day on October 14, 1066, providing insights into the impact of geography on its ultimate outcome.

In the conclusion to the study, a summary of research findings is presented. In addition, each of the research questions is revisited on a chapter by chapter basis, as part of an overall assessment of their contribution to the research problem presented in Chapter 1. This review is followed by a discussion of the contributions to Historical GIS. Furthermore, the conclusion offers insights into challenges associated with the project, possible future topics of research, and generalized summary statements at the end.

## Chapter 2

### 2 Sources and Debates on the Battle of Hastings

Given the focus of the thesis on the use of historical sources to derive a geographic perspective on the Battle of Hastings, it is important to understand what information is available that relates to the battle and how the event is understood within the literature. This chapter provides an overview of our knowledge on the battle and is divided into two distinct parts. The first part reviews in detail the various sources that are useful for understanding the battle, from contemporary literary accounts to documentary records, artistic representations, cartographic and GIS databases and environmental sources. The second presents a modern historiography of the battle. This part is followed by a concluding section which places the thesis within the context of the literature.

As will be shown, there has been much written about the Battle of Hastings. In fact, “more is known about . . . [this battle] than any other engagement fought in . . . [England] not only before 1066 but for centuries thereafter” (Lawson, 2003, p. 16). At the same time, the many different perspectives on these sources are largely dependent upon which discipline is concerned.

As mentioned in Chapter 1, in historical research there are two types of sources: primary and secondary (Rampolla, 2004, p. 5). Primary sources are written at the time of the event (contemporary sources) whereas secondary sources are the interpretations of the event written by later historians (Northey & Knight, 2005; Rampolla, 2004). In geography however, primary sources include information that has been obtained directly from the environment (earth) whereas secondary sources “are books and articles written by authors who have read and reflected upon a specific literature” (Northey & Knight, 2005, p. 5). Primary sources could also be considered original “data that are collected

and used by the same researcher, [while] secondary data are research data that have been collected by someone else” (Adler & Clark, 2003, p. 347).<sup>1</sup>

In this project, all contemporary or near contemporary sources will be considered as primary data. The environmental sources will also be considered as primary data. All modern works as discussed in the historiography below as well as the environmental interpretations will be considered as secondary data. Specific sources of both types include literary documents, administrative documents, artistic representations, maps, and environmental datasets.<sup>2</sup> They are briefly summarized in Table 1.1 and are discussed in detail below.

## 2.1 Contemporary Literary Sources

Several contemporary literary sources exist about the Battle of Hastings and the Norman Conquest in general. Given the origins of the two armies involved in the battle, these can be subdivided into English, Norman, and Anglo-Norman literary accounts which are examined individually in the sections which follow. Many of the document references are to specific published editions of the sources themselves. Collections of sources such as *English Historical Documents* Volumes I (1996) and II (1981) as well as Brown (1995) and van Houts (2000), are consulted as well. While these sources will be employed throughout the thesis to address all five of the research questions, they are particularly relevant to research questions 4 and 5 on the location and mapping narrative of the Battle of Hastings presented in Chapter 7.

### 2.1.1 English

Several Anglo-Saxon or Old English works have survived to the present day. These include the *Anglo-Saxon Chronicle*, the *Song of the Battle of Maldon* and the *Life of King*

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<sup>1</sup> The different perspectives of primary and secondary data are important because this project will be consulting sources from several disciplines which have their own view of primary and secondary data.

<sup>2</sup> The various types of sources written during this period are discussed in general by Clanchy in chapter 3 of his book on the written record from 1066 to 1307 (2013). In the historiography below, the studies examined focused purely on the literary and artistic sources with few cartographic depictions / environmental sources.

*Edward* (Brown, 1995). “The *Anglo-Saxon Chronicle* [ASC] was in fact a group of related but distinct vernacular annals compiled year to year and edited in different monastic centers” (Morillo, 1996, p. 21). The respective versions are “known as A, B, C, D and E” (Bradbury, 1998, p. 113). A diagram indicating “the relationship between manuscript versions of the *Anglo-Saxon Chronicle* and related texts” is presented in Swanton’s complete translation of the Chronicle (1998, p. xxix). In terms of scope, the ASC as a whole covers “English history from Julius Caesar . . . until 1154 . . . [in] Peterborough” (Brown, 1995, pp. 50-51), although in fact some versions ended well before 1154. In addition, the location of the chronicle indicates its bias; for example “C (from Abingdon) is hostile to the House of Godwine, E (from Canterbury in this period) has a strong bias in favour, and D (from the north) is largely neutral” (Brown, 1995, p. 51). Therefore, there is strong time and regional variation in the ASC. This trend is noteworthy because “each may give information not to be found in another” (Brown, 1995, p. 51), and thus a more complete account of the events in question can only be achieved by surveying all of the versions.<sup>3</sup> The editions of the ASC to be employed in this study are Swanton’s volume from 1998, and the account from *EHD II* (1981) in Brown’s book (1995).

The second Anglo-Saxon source is the Song of the Battle of Maldon. This source concerns a battle fought at Maldon (Essex) “against the Vikings in August 991” (Brown, 1995, p. 93). It was written at the time of the battle or in the early eleventh century. It is relevant to the Battle of Hastings because of “its vivid portrayal of late Old English military tactics, whether actual at Maldon in 991 or assumed then to have been adopted – the dismounting of all before the fight, and the defensive formation of the shield-wall” (Brown, 1995, p. 93). The version to be employed in this study is from Scragg’s chapter in his edited book on the battle (1991).

The *Life of King Edward* was an anonymous work believed to have been written in two parts at the time of the Norman Conquest (Brown, 1995, p. 80). The initial part concerns

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<sup>3</sup> For example, only ASC D contains evidence about the location of the battle (ASC (D), 1066, p. 199 vs. (ASC (E), 1066, p. 198).

the “history of Edward the Confessor’s reign” (Brown, 1995, p. 80) but it focuses on the history of the Godwines and is sympathetic to them because the patron of the work, Edith, Edward’s wife was Godwine’s daughter (Brown, 1995, p. 82). The second segment focuses on Edward’s religious life and was written following the Battle of Hastings (Brown, 1995, p. 80). The version analyzed in this project will be the edition located in Barlow’s translation (1962).

### 2.1.2 Norman

The Norman literary evidence that may be considered for the battle includes works such as the *Carmen de Hastingae Proelio*, William of Jumièges, and William of Poitiers’ biography of William the Conqueror known as the *Gesta Guillelmi* (Brown, 1995; Morillo, 1996).

One source, the *Carmen de Hastingae Proelio*, has been subject to debate because its accuracy has been questioned (Brown, 1995; Davis, 1978). Some have indicated it was composed well after the battle in the twelfth century (Davis, 1978, p. 259). If true, the *CHP* is “worthless as a source for the events of 1066,” (Morillo, 1996, p. 45). Most historians, however, accept it as reliable (Morillo, 1996, p. 45; Grainge & Grainge, 1996; Davis & Chibnall, 1998, p. xxviii).<sup>4</sup> As Davis has noted, even if it is from the early twelfth century, it could still contain evidence which would be relevant to the battle (Davis, 1978, p. 259). Hence, it is included as a source in this study. The edition employed here is Barlow’s translation (1999).

William of Jumièges’ work was “the earliest of the Norman literary sources relating to the conquest of England” (Brown, 1995, p. 1). However, his work contained less “detailed” accounts of the battle as he had never been a soldier (Morillo, 1996, p. 17). This fact would have influenced his account of the battle. According to Brown, 40

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<sup>4</sup> This reference was originally published as Grainge, C. & Grainge, G. (1993). The Pevensey Expedition: Brilliantly Executed Plan or Near Disaster? *The Mariner’s Mirror*, 79, 261-73. However in this study, the reference will be from a reprint: Grainge, C., & Grainge, G. (1996). The Pevensey Expedition: Brilliantly Executed Plan or Near Disaster? In S. Morillo, *The Battle of Hastings: Sources and Interpretations* (pp. 130-42). Woodbridge, UK: The Boydell Press.



versions of his work are believed to have existed in libraries throughout eleventh and twelfth century England and France (1995, p. 2). The translation by Elizabeth Van Houts will be employed in this study (1995).

William of Poitiers' account is not from the original manuscript. The current version is based on an edition published in the early seventeenth century by André Duchesne. Duchesne's version was derived from an already damaged manuscript. Unfortunately, it is believed that the original disappeared in the eighteenth century.<sup>5</sup> Therefore, there is little evidence pertaining to *WP* except from other sources.

The most prominent writer to mention *WP* was Orderic Vitalis in his *Ecclesiastical History* (Davis & Chibnall, 1998, p. xv). From Orderic, it is known that *WP* was a Norman soldier turned priest in the service of Duke William (Morillo, 1996, p. 3). By the late 1070's he was archdeacon of Lisieux (Brown, 1995, p. 16). His work is considered "the most important of our sources relating to the Norman Conquest, and certainly the most important for the invasion and campaign of 1066" (Brown, 1995, p. 15). The text itself has been well written and makes references to classical writers (Brown, 1995, p. 17). From a content perspective, it was "derived from personal knowledge and personal contacts . . . put together by a man uniquely qualified as both clerk and knight, closely connected with the court and, indeed for years part of it" (Brown, 1995, p. 17). Therefore, he had access to those who participated in the fighting. This fact makes it the most detailed source of the battle (Brown, 1995, p. 17). However, it has been argued that the author was a Norman and as such would have presented a view of the battle which was biased in favour of Duke William (DeVries, 2003, p. 6). In their introduction to the translation of *WP*, Davis & Chibnall do indeed claim that in some instances *WP* evaded the truth but also note that in general, he did not lie about the duke (1998, p. 42). The translated and edited version by Davis and Chibnall will be employed in this study (1998).

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<sup>5</sup> This caveat is important to note because this document is the main source for the development of the battle yet it is not the original text.

### 2.1.3 Anglo-Norman

The early twelfth century has been described as “one of the most distinguished periods of historical writing in England” (Brown, 1995, p. 98). Anglo-Norman writings by monks and clerics from the twelfth century include the works of William of Malmesbury, John of Worcester, Orderic Vitalis, Henry of Huntingdon and the *Chronicle of Battle Abbey*. Common amongst William, Orderic and Henry was they were all believed to have been of English and Norman parentage (Bradbury, 1998, p. 118).

The view of England from the pen of William of Malmesbury was that the people were sinful and Harold was a usurper. However, despite this fact, his works were generally sympathetic towards the English (Lawson, 2003, pp. 65-66 and 70). William, who was a monk at Malmesbury, wrote two key works, *Gesta Regum* on the English kings and *Gesta Pontificum* on the English church. He wrote about his own period, in the early to mid-twelfth century in the *Historia Novella*, as well as the works, the Life of St Dunstan, the Life of Wulfstan and a “history of Glastonbury Abbey” (Brown, 1995, p. 114). He employed “many of the techniques of a modern historian, cross-checking his sources and often drawing the reader’s attention to results which were” (Lawson, 2003, p. 64) according to Lawson (2003, p. 64), open to debate. William was also “able to read Old English as well as French and Latin” (Bradbury, 1998, p. 118). The translation of the *Gesta Regum* employed in this project is Mynors, Thomson, & Winterbottom’s edition which was published in 1998.

*The Chronicle of John of Worcester* was a contemporary work of the early twelfth century. There is a debate about its authorship between two writers - one being Florence of Worcester, and the other John of Worcester (Darlington & McGurk, 1995, pp. xvii-xviii). The chronicle, which covers the period up until 1140, was based on an account from Mainz<sup>6</sup> and a lost version of the ASC (Brown R. A., 1985b, p. 66; Darlington &

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<sup>6</sup> This chronicle is known by its author, the Irishman Marianus. He wrote in Mainz to 1076. According to WM’s *GP*, a copy came to England in the twelfth century (Darlington & McGurk, 1995, pp. xviii-xix).

McGurk, 1995, pp. xviii-xix). The version referred to in this thesis is the version translated by Bray and McGurk (1995).

Another contemporary, Orderic Vitalis, was “one of the most remarkable of the Anglo-Norman historians; and the *Ecclesiastical History* to which he devoted the last thirty years of his life is his greatest work” (Chibnall, 1969, p. xiii). He was born in 1075 near Shrewsbury but he spent much of his life, from the age of 10 until 1141, at the monastery of St. Evroult in Normandy (Brown, 1995, p. 99; Bradbury, 1998, pp. 118-9; Lawson, 2003, p. 110). He first “compiled a set of annals for his abbey, and . . . [then] at about the same time . . . he began revising the *Gesta Normannorum Ducum* of William of Jumièges” (Lawson, 2003, p. 110). He completed the majority of this undertaking by 1109. Following his extensive revision of William of Jumièges’ work, he wrote his own *Historia Ecclesiastica* where in a section he discussed the Battle of Hastings (Lawson, 2003, p. 111). As he was born in England, Brown notes that his writing had an English bias (1995, p. 99). Additionally, “[h]e is the only one to . . . name . . . the battle location as Senlac” (Bradbury, 1998, p. 119). This statement is a key observation which will be returned to in addressing question 4 in Chapter 7. This study will reference Chibnall’s translation of the original (1969).

The *Brevis Relato* is an anonymous literary source probably attributed to the work of a Norman monk at Battle Abbey. The document covers English and Norman history from the early eleventh to twelfth century (Lawson, 2003, p. 112). During the time when it was written, the abbot of Battle Abbey knew Duke William and thus it is possible he might have supplied first-hand accounts of the events of the Battle of Hastings to the author. Therefore, it may be considered another source for the battle. The version this thesis will draw its evidence from is van Houts’ translation (1997).<sup>7</sup>

Another key Anglo-Norman author of the early twelfth century was Henry of Huntingdon. Henry was an archdeacon at Huntingdon and his work, *Historia Anglorum*

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<sup>7</sup> The translation is presented in: Van Houts, E. M. C. (1999). *History and Family Traditions in England and the Continent, 1000 – 1200*. Aldershot, UK: Ashgate Publishing Limited. The notes on the document are included in the reproduction of the original article as referenced above.

was widely known and copied (Bradbury, 1998, p. 119). His writing covers the period from the Romans until 1154 (Bradbury, 1998, p. 119; Lawson, 2003, p. 70). Henry saw the Norman Conquest as God's retribution for the people's sins and hence did not write favourably towards the Godwine family (Lawson, 2003, pp. 70-1). According to Greenway, Henry did see himself as English and therefore tended to ignore the groups in the British Isles who were not English (2009, p. xix). The translation employed in this study is from Greenway's edition (1996).

Yet another source, the *Chronicle of Battle Abbey*, is an anonymous chronicle written in the later twelfth century in the reign of Henry II. The abbey was founded by Duke William after the battle as a penance (Lawson, 2003, p. 121). The account details the abbey's founding. However, the author employed "documents forged in the abbey to make a case, and there is little doubt that some of his claims are false. The difficulty is to know if others are true" (Bradbury, 1998, p. 120). Therefore, although there are some concerns with credibility, the main benefit of this source lies in the details it provides, such as local place names (Bradbury, 1998, p. 120). The edition which will be employed in this project will be Searle's translation (1980).

The final Anglo-Norman writer to be considered is Wace. Wace came from Jersey and "was educated in Caen and Paris and eventually returned to Caen" (Lawson, 2003, p. 114). He wrote the *Roman de Rou* in French about the Norman dukes from Normandy's founding in the early tenth century until the Battle of Tinchebrai (1106) (Lawson, 2003, p. 114). He referenced other works from the period such as William of Poitiers, William of Malmesbury and Orderic Vitalis (Lawson, 2003, p. 114). Therefore, he is considered "a serious historian" (Lawson, 2003, p. 114). The translation employed in this study will be from Burgess and van Houts' edition (2004).

## 2.2 Documentary Sources

Beyond the literary evidence, several contemporary documents have survived from the time of the Norman Conquest. The key difference between these sources and the literary sources listed above is that, according to Brown, they "lack the subjective element of the literary work," (1995, p. 122) and thus would have been considered less subject to bias.

Several of these documents are presented in Brown's work. The document types considered as part of this study are surveys and laws and customs (Clanchy, 2013, p. 87). These documents cover the periods both before and after the Norman Conquest. Brown's book also includes letters between some of the principle participants of the Norman Conquest (1995). All such sources are particularly important to addressing questions 1 to 3 in Chapters 4 to 6, especially with regard to how the armies were assembled and the mapping of local land uses for understanding how local resources were accessed by the respective armies.

### 2.2.1 Surveys

The key documentary source used in this study is a survey referred to as the *Domesday Book* or the "*Liber de Wintonia* (The Book of Winchester)" (Morris, 1976). The *Domesday Book* resulted from efforts by King William in "each shire to enquire in great detail about its resources and who held them" (Darby, 1977, p. 3) in 1086.<sup>8</sup> The reason for the survey was "the constant Norman preoccupation with the exploitation of England's wealth, a need which had been given even greater urgency by the invasion scare of . . . the Danish menace in 1085-86" (Bates, 2008, pp. 260-3). The main questions of the survey were recorded for the abbey of Ely (Morris, 1976). The answers were "arranged in five main groups: (i) the place and its holder, its hides, ploughs and lordship; (ii) people; (iii) resources; (iv) value; and (v) additional notes" (Morris, 1976). The name Domesday comes from the *Dialogue of the Exchequer* by Richard Fitz Neal in the later twelfth century which presented that "the book had been called *Domesdei* 'by the natives' because it seemed to them like the Last Judgment" (Clanchy, 2013, p. 25; Roffe, 2000, p. 5).

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<sup>8</sup> A survey is "a study in which the same data, usually in the form of answers to questions, are collected from members of the sample" (Adler & Clark, 2003, p. 231). This survey was conducted through a structured interview because the commissioners read the questions to the people and they verbally responded. The commissioners then recorded the answers (Adler & Clark, 2003, p. 231). For further discussion on surveys or structured interviews in a modern academic context, see Adler & Clark, chapters 9, 10 and 14 (2003).

The main study of the *Domesday Book* was undertaken by Darby who has detailed the entire survey in his work, *Domesday England* (1977). He also published studies on individual shires, such as Sussex (King, 1962). This study is important because it provides a detailed geographic analysis of the source. However, there are limitations to Darby's study. For example, there exist entire sections of the analysis which rely on aggregated data, where in fact non-aggregate data would be preferred to help identify local trends (see Chapter 3 for more detail on this point). A full copy of the *Domesday Book* can be accessed in GIS format from the *Prosopography of Anglo-Saxon England* (PASE) website. This dataset was produced by King's College, London (2010) with an accompanying guide (Baxter & Jessop, 2010). The text of the *Domesday Book* for Sussex can be accessed through the edition edited by John Morris (1976) or digitally through the UK Data Archive.<sup>9</sup>

The other important survey of the time is the Burghal Hidage (*BH*) survey from England in the early tenth century (Hill & Rumble, 1996, p. 2). This document records "thirty-three places, to each of which a number of hides . . . were allotted" (Hill & Rumble, 1996, p. 1).<sup>10</sup> There is also a calculation which explains the amount of resources and number of men required per length of town wall (Rumble, Hill, & Brooks, 1996, p. 70). However, it is assumed that the *DB* provides a more accurate reflection of hides to military service (Powicke, 1962, pp. 19-20). The version referenced in this project comes from the edited book *The Defense of Wessex* by Hill and Rumble (1996, pp. 32-5). The list is also presented in Brown (1995, pp. 157-8) and Lavelle's (2010, p. 211) books.

The third survey document considered in this study is the ship list of William the Conqueror. This list indicates who provided ships to William for the Norman Conquest. For some nobles, the list indicates the number of warriors supplied as well. The only

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<sup>9</sup> The digital text is a copy of the translation produced by John Morris (1976). The *Domesday* references are to the Morris edition.

<sup>10</sup> A hide "probably originated as an amount of land needed to support a peasant family for a period of one year and, at the same time, as a unit of tax assessments. But, beginning in the eleventh century, the hide was usually expressed in terms of acres, with . . . [between 60 and 180] acres being the most common" (Zupko, 1968, p. 76).

comprehensive analysis of the document was conducted by Van Houts (1987). In her article, Van Houts uses the list to detail the home locations and ports of the nobles (1987, pp. 178-9). This project draws upon this source (1987) and also a translation of the ship list itself which is located in Van Houts edited collection (2000, pp. 130-1).

The final survey to be considered is the *Infeudationes Militum (IM)* of 1172 which can provide considerable insight into military service in Medieval Normandy. It includes “the fief, the name of the tenant, the number of knights owed to the duke and the [total] number of knights enfeoffed” (Van Houts, 1987, p. 170). Not all of Normandy is recorded, however, as some lords did not participate in or reveal all of their vassals (Verbruggen, 1977, p. 9). In her article on Duke William’s ship list, Van Houts, however, does provide a thorough assessment and thus some validation, of *IM*’s tally (1987, pp. 170-1). Thus, this source, which is discussed in further detail in Keefe’s *Feudal Assessments and the Political Community under Henry II and his Sons* (1981), should be considered relevant to the Norman Conquest.

## 2.2.2 Laws and Customs

Documented laws and customs are also particularly useful in studies on the Battle of Hastings. In Brown’s book, there are a collection of sources for both England and Normandy from before or a few years after 1066. These include “The Rights and Ranks of People” or *Rectitudines Singularum Personarum*, “The Customs and Rights of the Duke of Normandy” or *Consuetudines et Justicie*, and the Penitential Ordinance of Bishop Ermenfrid of Sion (c. 1070) (Brown, 1995, pp. 149-53 and 156-7).<sup>11</sup> The first document describes the operations of an English manor at the time of the Norman Conquest (Harvey, 1993, p. 1). This document is pertinent to this study because of its relevance to the military and social organization of the time (Hollister, 1962, p. 70). The second document discusses the rights which Duke William possessed in Normandy from before 1066. However, they were recorded well after the event in 1091 during the reign

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<sup>11</sup> The original reference for the penitential ordinance was Cowdrey, H. E. J. (1969). Bishop Ermenfrid of Sion and the Penitential Ordinance following the Battle of Hastings, *Journal of Ecclesiastical History*, XX, p 225-42.

of his son Robert. The final source details the penance for the soldiers who participated in the battle (Brown, 1995, p. 156). This project will employ the translations as published in Brown's book (1995) and *EHD* II (1981).

## 2.3 Artistic Representations

There are a limited number of artistic representations of the Battle of Hastings. The principal and most famous of these is the Bayeux Tapestry. This tapestry depicts the events leading up to, and during the battle (Stenton, 1965). In addition to the tapestry itself as an historic source, it also appears in most secondary works on the battle (Bradbury, 1998; Brown, 1995; Lawson, 2003; Morillo, 1996; Wood, 2009; Brown, 1996). References to the tapestry are relied upon extensively in this study, particularly in addressing research question 5 in Chapter 7. Five reprints from the tapestry also appear in Chapter 7.

### 2.3.1 Bayeux Tapestry

The historical value of the Bayeux Tapestry (*BT*) has been well discussed in the literature on the Norman Conquest (Bradbury, 1998; Brown, 1995; Lawson, 2003; Morillo, 1996; Stenton, 1965; Wood, 2009; Brown, 1996). The *BT* is in fact an embroidery "measuring 70.34 metres by 50 centimetres" (Wormald, 1965, p. 25) and has had a long eventful history, as chronicled by Bertrand in Stenton's edited work (1965). Other examinations of the tapestry discuss the event itself (The Norman Conquest), as well as specific artistic elements such as its architecture, design and production (Brown R. A., 1965; Digby, 1965; Stenton, 1965; Wormald, 1965). Representations of clothing and armour are also explored (Mann, 1965; Nevinson, 1965).

The tapestry presents a rare contemporary depiction of the battle and illustrates several features in the natural landscape, including hills and a watercourse (Stenton, 1965, pp. Plates 66-7; Lawson, 2003). The landscape elements are also widely discussed within the secondary literature which discusses these elements with respect to other sources on the



battle<sup>12</sup> (Bradbury, 1998; Lawson, 2003, pp. 149-52; Wood, 2009). However, the *BT* is not without its shortcomings. For example, some of the design elements were thought to be simple representations of artistic manuscripts originating from Canterbury where the tapestry was believed to have been woven (Bradbury, 1998, pp. 114-115; Wormald, 1965). The *BT* references used in this thesis are derived from the reproduction in Stenton's edition (1965).

## 2.4 Cartographic Sources and GIS Databases

There is a wealth of historical and modern cartographic sources and GIS databases available to this project from England, Normandy, and the Hastings area specifically. They consist of historical maps, geospatial data, the Ordnance Survey of Great Britain, an historical environmental record, historical parish boundaries, and high resolution point data. In the study, most of these sources are employed as reference data but they do provide a further layer of evidence complementing the written records discussed previously. Each of these sources will be discussed in turn. It should be noted that these data are particularly relevant to the mapping of England and northern France undertaken in Chapter 4 in response to research question 1. They are also relevant to the local land uses and topographical changes in the Hastings area addressed in Chapters 5 and 6, as well as efforts to locate and map the course of the battle in Chapter 7. Given their importance, each of the sources will be discussed briefly in turn in the following sections.

### 2.4.1 Historical Maps

Several historical maps were consulted for this project. They range in date from the mid-fourteenth century until the early twentieth century. The majority of the maps focus on East Sussex, however an early eighteenth-century map of Normandy and a fourteenth-century map of England have also been included. There have been no comprehensive studies which have examined historical maps with respect to the Norman Conquest.

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<sup>12</sup> The Hastings battlefield will be explored below in the historiography section of the chapter.

However, Appendix A is a copy of a study by the author which examined a selection of relevant maps to the Norman Conquest. Each of these sets of maps will be examined below, in chronological order.<sup>13</sup>

The Gough Map is “the earliest surviving map of Britain that shows the island in a geographically recognizable form” (Lilley, Lloyd, & Campbell, 2009; Lloyd & Lilley, 2009, p. 29).<sup>14</sup> It is believed to have been developed in the fourteenth century but some authors place its date in the late thirteenth century (Lilley, Lloyd, & Campbell, 2009; Lloyd & Lilley, 2009, p. 29). The map can be viewed and searched digitally through a dedicated website (King's College, London, 2011).<sup>15</sup>

There are two maps from the late sixteenth century, as discussed in Appendix A, which depict the coast of Sussex in detail. These maps were developed for defense purposes during the time of the Spanish Armada (1588).

The Delisle map of Normandy represents the local roads, forests, rivers and settlements of the duchy from the early eighteenth century (1716). As the map was produced prior to the French Revolution it is generally considered more reliable than those drawn afterwards, due to the fact the internal borders of France were re-arranged after 1789 largely for administrative purposes. In England, it is assumed that borders changed very slowly in the centuries before the nineteenth century (Hoskins, 1977, p. 79) as even the parish boundaries are applicable back to 1500 (see Section 5.4.5). Thus, based on this observation, one may reasonably assume that the boundaries from the early eighteenth century are similar to those of the eleventh. This map can be accessed through an online map collection (Cartography Associates, 2012).<sup>16</sup>

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<sup>13</sup> For further discussion on these maps see Appendix A.

<sup>14</sup> There were maps developed by Ptolemy in the second century AD however, no originals survive (Cosgrove, 2007, p. 83). There are renaissance reconstructions but they post-date the Gough map.

<sup>15</sup> <http://www.goughmap.org/>

<sup>16</sup> [www.davidrumsey.com/](http://www.davidrumsey.com/)

The most detailed map of the entire study area is the Yeakell and Gardner map from the eighteenth century (1783). This map has been deemed along with another map by the same cartographers to be, “the most important of all Sussex maps” (Kingsley, 1982, p. 91), because it accurately presents the land uses and roads of that time period (Kingsley, 1982, p. 92). These roads will be relevant to this project because “[f]ew new roads were created between Saxon times and the turnpike and ‘enclosure’ roads of the eighteenth century” (Hoskins, 1977, p. 242).<sup>17</sup> Therefore, the local medieval road or simple track network could be derived from this map. A digital copy of the map sheets can be located through a University of Sussex website (Fontana, 2000).<sup>18</sup>

### 2.4.2 Geospatial Data

For northern France, a basic GIS dataset was accessed through the Map Library at the University of Western Ontario. These data included boundary files for the European countries as well as point files for towns and cities. Local rivers could also be accessed. The data follows the North American Datum of 1983 (ESRI Data & Maps, 2008; Kimerling, Buckley, Muehrcke, & Muehrcke, 2009, p. 461).

### 2.4.3 Ordnance Survey

The Ordnance Survey of Great Britain (OS) has produced three maps which cover the Battle area in some detail. A printed map at a scale of 1:25000 from the “*Pathfinder*” series provides both the topography and land uses (Perkins & Parry, 1996, pp. 54-61).<sup>19</sup> It also provides names of locations which could prove useful in interpreting the landscape (Ordnance Survey, 1992). However, this map is printed and not currently available in GIS format, thus limiting its use in this study.

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<sup>17</sup> These additions to the road network will be considered when developing the medieval road network.

<sup>18</sup> <http://www.envf.port.ac.uk/geo/research/historical/webmap/sussexmap/sussex.html>

<sup>19</sup> A detailed list of what is displayed in the “*Pathfinder*” maps is available in Perkins and Parry’s book (1996, pp. 57-8).

The digital vector-based dataset is the 1:50,000 scale maps of Great Britain known as the “*Landranger*” series (Perkins & Parry, 1996, pp. 61-68; Ordnance Survey, 2012). These maps include many different elements such as buildings, infrastructure, place-names,<sup>20</sup> railways, roads, and water bodies (Perkins & Parry, 1996, pp. 64-65; Ordnance Survey, 2012). However, they do not include the topography. For elevation data, another dataset, known as the “*Panorama*” series will be accessed. The *Panorama* series includes contour lines and accompanying digital elevation models or DEMs at a raster resolution of 50 m (Perkins & Parry, 1996, p. 67). All GIS data is disseminated in 100 km<sup>2</sup> blocks based on the British National Grid coordinate system (Kimerling, Buckley, Muehrcke, & Muehrcke, 2009, p. 69; Ordnance Survey, 2012). All of these data will be accessed from the Ordnance Survey website (Ordnance Survey, 2012).

There is also a wide range of Ordnance Survey maps from the early twentieth and nineteenth centuries which can be accessed. In this study the maps from the first and third edition will be reviewed. The first edition maps were drawn in the early 1800’s and revised in the 1880’s particularly with the addition of the railroad. The copies in use here were reprinted in the late 1960’s with a detailed description accompanying each map (Sheet 73 Sheerness and Dungeness, 1969; Sheet 88 Hastings, 1969). The third edition was surveyed during the First World War and represents the start of the interwar period between the First and Second World Wars (Brighton & Eastbourne, 1920; Hastings, 1921). These maps were accessed through the Map Library at the University of Western Ontario and scanned.

#### 2.4.4 Historic Environmental Record

The environmental record of the Hastings area is accessible using a GIS vector-based database which records the land uses and historic periods of features in the landscape. The main columns in this database are the characterization, sub characterization and period. There is also a text column which provides an interpretation of the location. The

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<sup>20</sup> The local place-names are discussed in the English place-name society’s reference books on place names. The reference book employed in this study will be the Sussex edition (Mawer, Stenton, & Gover, 1930).

land use classifications are discussed in Rippon's book through several examples including Cornwall (2004, pp. 101-3) and Lancashire (2004, pp. 106-9). Rippon's book also provides numerous cartographic examples including examples with *Domesday* data (2004, pp. 129-31). Bannister has developed several documents which provide various interpretations of the Sussex database (SHLC - II, 2010). These are available online. The database for this project was accessed through the East Sussex Historical Environmental Record (ESHER, 2013).

#### 2.4.5 Historical Parishes and Counties

Information on historical parishes and counties of England is available from a GIS database containing data from 1500 to 1851. The file was digitized from another study which looked at nineteenth-century parishes.<sup>21</sup> This data can be accessed through the UK Data Archive. (Burton, Westwood, & Carter, 2004).

#### 2.4.6 High Resolution Point Data

For this study, high resolution point data used to map out the battlefield was purchased commercially from Stanfords Business Mapping. The extent of the data was roughly a four square kilometer box which was centered on the town of Battle, with all of the buildings and trees removed. The data format was points spaced approximately 5 m apart. When interpolated into a 5 m resolution raster, these points represent the modern landscape (Stanfords Business Mapping, 2009).<sup>22</sup>

### 2.5 Environmental Sources

Sources indicating the state of the present and historical environment in the Hastings area were examined in this study, and used primarily to address research questions 2 and 3 in Chapters 5 and 6 with regard to the local topographical changes and resources. Variables

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<sup>21</sup> Kain, R.J.P., and Oliver, R.R. (2001) "Historic Parishes of England and Wales: Electronic Map - Gazetteer - Metadata", Colchester, UK: History Data Service. This dataset was based on the historical Ordnance Survey maps as discussed previously.

<sup>22</sup> Foard and Curry's study of Bosworth selected topographic data of a similar resolution (2013, p. 75).

examined included crop yields, precipitation reconstructions, soil factors and raw environmental measurements. Each is discussed in turn below.

### 2.5.1 Crop Yields

The crop yield data are derived from “surviving medieval manorial accounts . . . [which] contain all the information . . . [to calculate] the yields of specific crops . . . in dated years” (Campbell, 2007). An example of a medieval record is presented on Campbell’s website as well as in Titow’s book on Winchester crop yields (Campbell, 2007; Titow, 1972, pp. 5-7). The data can be presented as either yield per seed or per acre.<sup>23</sup>

Aggregated data can be located in Brandon’s article (1972), while raw data can be accessed from Campbell’s website or Titow’s book (Campbell, 2007; Titow, 1972).

### 2.5.2 Iron Sites

The location of iron mines in the Hastings area can be accessed from an online database of iron sites. The database provides details about the site such as the historical period, grid coordinates, nearby river, references and type of iron work (Wealden Iron Research Group, 2013). For this project, the period of interest is all Roman, Saxon and Medieval sites. The database can be accessed through the Wealden Iron Research Group website (2013).

### 2.5.3 Precipitation Reconstructions

Two historical precipitation datasets were considered for this project. One was discussed in the paper by Wilson et al. (2012) and the other in the paper by Cooper et al. (2012). These datasets were derived from dendrochronology which examines tree rings. The basic focus of dendrochronology is that “each ring has individual characteristics that reflect annual changes in growing conditions . . . [and t]hey can use these data to go back

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<sup>23</sup> The yield per acre is only applicable when fields were measured with statute acres (Titow, 1972, pp. 16-20). See Titow’s Appendix Q as well for further evidence (1972, pp. 150-1).

in time” (Howell & Prevenier, 2001, p. 50).<sup>24</sup> The two datasets were accessed from the National Oceanic and Atmospheric Administration (NOAA) web site.

#### 2.5.4 Soil Factors

Soil erodibility or “K” factor “represents the effect of soil properties and soil profile characteristics on soil loss” (Renard, Yoder, Lightle, & Dabney, 2011, p. 142).

Following an examination of the UK’s online soil data viewer, it was determined that the vast majority of the soils in the Hastings area (Figure 1.1) were clay / loam soils and hence very similar in characteristics (Cranfield University, 2012). Consequently, it was inferred that the erodibility value would be fairly uniform as well (Brady & Weil, 2004, p. 529). Therefore, the erodibility values as presented in the European Soil Database would provide the desired accuracy (European Communities, 2013). These data were derived from soil samples which were surveyed and mapped in 2009 (European Communities, 2013; Panagos & Montanarella, 2011; Panagos, Meusburger, Alewell, & Montanarella, 2012). The “K” factor for the study area is 0.045.<sup>25</sup>

Soil density is “[t]he mass of dry soil per unit of bulk volume, including the air space. The bulk volume is determined before drying [the sample] to a constant weight at 105°C” (Brady & Weil, 2004, p. 570). As indicated above, the vast majority of the local soils have similar characteristics. Therefore, a uniform bulk density can be applied to the study area as well. This bulk density for clay / loam soils is 1.3 Mg/m<sup>3</sup> or 1300 kg/m<sup>3</sup> (Morgan, 2005, pp. 131-2).

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<sup>24</sup> For a more detailed examination of dendrochronology, see the dendrochronology section in Lowe and Walker’s book (1997).

<sup>25</sup> This value is the average for the three cells in the dataset which were near Battle.

### 2.5.5 Environmental Measurements

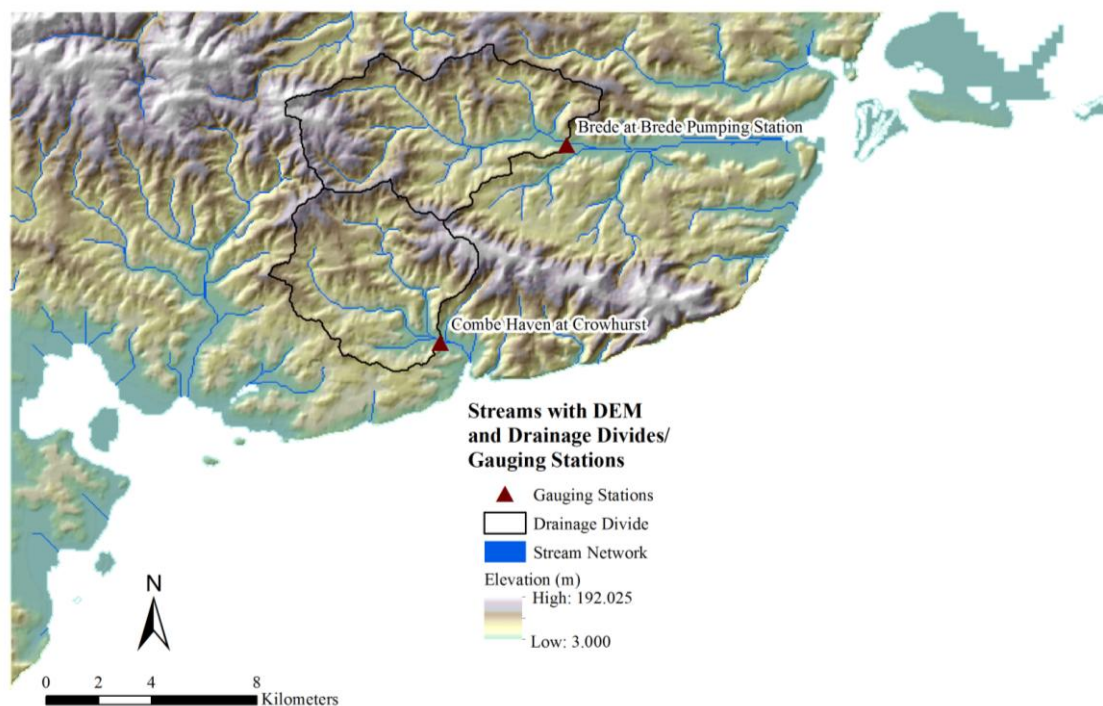
The drainage basin<sup>26</sup> which drains the Hastings Battlefield has been monitored since about 1970 (Figure 2.1). Through the Centre for Ecology & Hydrology in the UK, these data can be accessed in the form of monthly precipitation which is measured in millimeters. These measurements have been assumed to be uniform over the entire basin. Daily discharge can also be accessed as well which is measured in cubic meters per second (CEH, 2013). This data is measured at gauging stations whose locations are depicted on the map (Figure 2.1). Figure 2.1 also defines the drainage divides of the areas which contribute to the two respective gauging stations.<sup>27</sup>

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<sup>26</sup> The drainage basin is “an area within which water supplied by precipitation is transferred to the ocean, a focus of internal drainage, such as a lake, or to a larger stream” (Summerfield, 1991, p. 207).

<sup>27</sup> The drainage divide is “[t]he surface trace of the boundary that delimits a [drainage basin]” (Dingman, 2008, p. 10).





**Figure 2.1: Extent of Drainage Basins and Gauging Station Locations for Recorded Hydrologic Data (2013) with Calculated Drainage Network from DEM (2012)<sup>28</sup>**

Just over 20 kilometers from Battle is Eastbourne which has easily accessible precipitation and temperature data going back to the late 1950's. However, since precipitation is highly spatially dependent but temperature is not, only the temperature data from Eastbourne will be considered in this project (Met Office, 2013).

## 2.6 Historiography of the Battle

As previously stated, much has been written about the Battle of Hastings. In fact, this battle is one of the most documented battles in British history (Lawson, 2003, p. 16). The literature extends from the time of the battle until the modern day and can be divided into

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<sup>28</sup> The DEM came from the Ordnance Survey (2012) while the extent of the drainage basins and the locations of the gauging stations were accessed from the *CEH* (2013).

two categories, popular and academic history.<sup>29</sup> An excellent introduction to the academic historiography of the battle is Chibnall's *The Debate on the Norman Conquest* which explores this subject as late as the later part of the twentieth century (1999).

In the following historiography, both categories of historical literature from the twentieth and twenty-first centuries will be reviewed. A summary of the works on the battle from both the Anglo-Saxon and Norman perspectives, as well as a discussion of specific accounts of the armies' organization, size and tactics, landscape and the course and aftermath of the battle will be included. Considerations of the landscape and cartographic depictions of the battle will also be presented. This summary helps us to understand what modern commentators know about the Battle of Hastings, and is used throughout this study to address all five of the research questions presented in the introduction.

### 2.6.1 Surveys of Literature on the Battle

An excellent starting point to understand the battle is Gravett's illustrated popular history. Gravett provides an introduction as well as references to additional literature (1992). Beyond this, Huscroft includes three key references on the Battle of Hastings (2009, p. 339). The first is Lawson's book entitled *The Battle of Hastings 1066* (2003) followed by Morillo's book entitled *The Battle of Hastings: Sources and Interpretations* (1996). The final work by Brown, entitled "The Battle of Hastings", is reproduced from its original publication in Morillo's work (1996) and in another edited work by Strickland (1992). Three other useful works include Bradbury's *The Battle of Hastings* (1998); Wood's *The Battle of Hastings: The Fall of Anglo-Saxon England* (2009); and Grehan and Mace's recent *The Battle of Hastings 1066 - The Uncomfortable Truth: Revealing the True Location of England's Most Famous Battle* (2012).

According to Huscroft, the most thorough survey analysis of the battle is Lawson's book. The books by Morillo and Strickland offer reprints of articles on the period / battle, and

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<sup>29</sup> As discussed in Chapter 1, popular history is more of a general study with few details whereas academic history is detailed but not for a general audience.

are also useful in providing in one place different historians' views on the battle per se or related concepts.

## 2.6.2 Perspectives on the Battle

Within the broader literature, there exist two main perspectives that have persisted since the Battle of Hastings and the Norman Conquest. The Anglo-Saxon perspective, following in the tradition of the *ASC*, considered it a disaster (Swanton, 1998) whereas many of the Norman sources including, William of Poitiers, regarded it as a great victory (Davis & Chibnall, 1998). These perspectives have influenced how modern historians have viewed the battle. In the following subsections, each perspective will be discussed.

### 2.6.2.1 Anglo-Saxon

As stated above, the Anglo-Saxon view of the battle is one of tragic loss (Wood, 2009). The *D* account of the *ASC* for 1066 sums up the year with the line “[w]hen God wills, may the end be good” (*ASC (D)*, 1066, p. 200). One of the earliest modern sources on the Anglo-Saxon perspective was E. A. Freeman. He wrote in the later nineteenth century and published several volumes on the Norman Conquest (Morillo, 1996, p. 149). According to Lawson, Freeman demonstrated a pro-Anglo-Saxon bias which he attributes to the difficult political relations with France at the time he was writing (Lawson, 2003, p. 28). Lawson himself, however, exhibits a similar bias insofar as he begins in the introduction of his own work with comments about how the English government declined under the Normans. He also relates the Conquest to the threat from Germany in World War II (Lawson, 2003, p. 15 and 19). Lawson additionally thanks several well known Anglo-Saxonists such as James Campbell in his forward (Lawson, 2003, p. 13).

Other key Anglo-Saxonists include Abels, who focused on the concepts of military service in England before the Norman Conquest (1988; 2001; 1991). For his part, Higham has detailed the end of Anglo-Saxon England (1997, pp. 229-30) and in a more recent book, the Norman Conquest itself which he concludes with a quote from Freeman (1998, p. 111) clearly signaling his point of view. Another work by Hollister professes confidence in English governance of the time and attributes the loss at Hastings to “bad luck” (1962, pp. 150-2).

### 2.6.2.2 Norman

As initially indicated, the Normans of the time viewed the battle as a great victory. For example, *WP* states “this account of the battle which he [William] bravely and justly won” (*WP*, p. 137). This point of view is consistent with modern interpretations including J. H. Round who wrote in the late nineteenth century and contradicted the English view written by Freeman (Morillo, 1996).

In the later twentieth century, R. Allen Brown published a number of works on the battle and the Norman Conquest in general (1996; 1985b). In addition, Morillo’s work focuses on the Normans, including his article (1990) featured in his edited work on the Battle of Hastings (1996). Morillo has similarly written a book on Anglo-Norman warfare that focused more on the period following 1066 (1994). In that study, Morillo demonstrates the importance of the *familia regis* to organizing and maintaining the military. The *familia regis* or “*familia* was the military system, for the influence of its members, if not its actual structure, [which] reached into every aspect of the Anglo-Norman military machine” (Morillo, 1994, pp. 60-1). In Strickland’s edited book, contributors such as Bradbury, Chibnall, Gillingham and Prestwich convey a Norman perspective to the battle and the conquest (1992).

### 2.6.3 Military Strategy

Insofar as this thesis undertakes to understand the history and outcome of the Battle of Hastings through a geographical lens, it is important to understand the military strategies of the period which have been represented in the literature. There have been several important studies on medieval warfare in general throughout the twentieth century. One of the main early-twentieth century authors on medieval warfare is Sir Charles Oman. His book on the subject entitled *A History of the Art of War in the Middle Ages* is an important source of knowledge for the period. The book covers the rise of cavalry from the late Roman Empire until the late thirteenth century (Oman, 1924). A mid-twentieth century writer on medieval warfare is Verbruggen with his book: *The Art of Warfare in Western Europe during the Middle Ages*. This book was originally published in 1954 in Dutch and republished over 20 years later in English. The book discusses troop types,

tactics and strategy (Verbruggen, 1977, pp. xi-xiii). There are several mentions of Hastings throughout the book but it does not include a detailed analysis of the battle.

The key late-twentieth century text on warfare during the medieval period is *War in the Middle Ages* by Contamine (1986). The book is divided into three parts, the first of which contains a chapter devoted to events of the eleventh century. The second part explores specific military themes, while the final section is a detailed bibliography. Guy Halsall's book on barbarian warfare focuses on war before Hastings. Nevertheless, some of the concepts and conclusions are important, especially the ideas surrounding the Anglo-Saxon type of warfare (2003). One excellent illustrated book which covers both Anglo-Saxon and Norman military strategy and tactics is Dougherty's book on medieval warfare (2008). Another book which covers both these topics is Keen's book on medieval warfare (1999). However, Dougherty's book begins in the year 1000 whereas Keen's book includes a chapter which goes back to Carolingian times in the eighth to ninth centuries and before (Reuter, 1999). Therefore, the origin of the type of warfare undertaken in the eleventh century receives a more thorough historical treatment in this source.

In the following subsections, sources describing the general military organization, army size and strategy are presented for the Anglo-Saxon and Norman armies.

### 2.6.3.1 Anglo-Saxon

Currently there are three key books on the Anglo-Saxon military in this period. The most recent is Lavelle's work which covers the period from Alfred the Great in the late ninth century until the Battle of Hastings (2010). The other two books examine military service in the Anglo-Saxon period (Abels, 1988) and the military institutions in late Anglo-Saxon England (Hollister, 1962). Portions of Abels' and Hollister's works are reprinted in Lavelle's study (2010). Another study by DeVries focuses on the Viking Invasion in 1066 which preceded the Norman Conquest. This book devotes a chapter to the English army in 1066 as well as to the campaign and battle (DeVries, 2003). An important note is made by Lavelle who indicates that historians' views of Anglo-Saxon

warfare have been influenced by later battles such as the Battle of Agincourt<sup>30</sup> from the early fifteenth century (2010, p. 134).

### 2.6.3.1.1 Organization

As indicated above, the most recent study on the Anglo-Saxon military is Lavelle's work (2010). In this book, the author covers both land and naval organization and includes reprints from the works of Abels (1988), Hollister (1962) and Hooper (1992a).<sup>31</sup>

One element of the Anglo-Saxon military which sources tend to agree upon is its organizational structure. A number of authors have affirmed that typically armies were divided into shires and hundreds which saw soldiers of similar origins aggregated into similar sized units (Abels, 1988, pp. 66-7 and 179-81; Hollister, 1962, pp. 91-3; Abels, 1991, pp. 145-6; Lavelle, 2010, p. 106).<sup>32</sup> This finding strongly suggests that the troops who came from one area or region would have fought together, a fact that would be relevant to any mapping exercise associated with the battle.

Another concept which has been widely discussed is the hides and the five hide rule (Abels, 1988; Hollister, 1962; Lavelle, 2010; Powicke, 1962). The hide was the basic unit of military recruitment in the select *fyrð* by which eligibility of military service was determined (Hollister, 1962, p. 115). The general rule was those possessing five hides or more were required to serve in the army and those possessing 300 hides or more were required to provision a ship (Bradbury, 1998, p. 76). The five hide rule and its

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<sup>30</sup> The English at Agincourt were on foot so similar to the Anglo-Saxon style of warfare.

<sup>31</sup> This reference was originally published as Hooper, N. (1989). Some Observations on the Navy in Late Anglo-Saxon England. In *Studies in Medieval History presented to R. Allen Brown*, eds. C. Harperbill, C. Holdsworth, and J. L. Nelson (Woodbridge, UK) pgs. 203-13. However in this study, the reference will be from a reprint: Hooper, N. (1992). Some Observations on the Navy in Late Anglo-Saxon England. In M. Strickland, *Anglo-Norman Warfare: Studies in Late Anglo-Saxon and Anglo-Norman Military Organization and Warfare* (pp. 17-27). Woodbridge, UK: The Boydell Press. The study has also been reprinted as: Hooper, N. (2010). Some Observations on the Navy in Late Anglo-Saxon England. In R. Lavelle, *Alfred's Wars: Sources and Interpretations of Anglo-Saxon Warfare in the Viking Age* (pp. 152-63). Woodbridge, UK: The Boydell Press.

<sup>32</sup> A hundred is "a neat administration, in which each Hundred contained 100 hides and each hide a hundred acres" (DB Sussex, 1976).

importance to military service are discussed further with regard to question 1 in Chapter 4.

### 2.6.3.1.2 Army Size

Several estimates regarding the size of the Anglo-Saxon army at Hastings have been put forward by historians. The values range from 5000 to 13000; however, the most accepted number is approximately 8000 (Lawson, 2003, pp. 141-3; Huscroft, 2009; Gravett, 1992). Halsall has suggested that according to literary sources, army sizes and numbers in general during this period tended to have a religious or poetic connection (2003, p. 121). For example, many numbers came from the bible or sounded poetic (Halsall, 2003, p. 121). There have also been accounts suggesting that the Anglo-Saxons had horses in their armies, but they still dismounted to fight (Lavelle, 2010, pp. 134-7 and 282-5). This theory is discussed in the literature dating back to Roman times where the Roman general Narses was believed to have his men dismount to fight on foot (Oman, 1924, p. 34).<sup>33</sup> A discussion of horses for military use in Anglo-Saxon England is presented in Davis' book on warhorses (1989, pp. 70-8). These and other issues related to army size and composition are discussed further in Chapter 4 in relation to research question 1. They are also relevant to question 3 in Chapter 6 as the number of men and horses in the respective armies helped to dictate the amount of resources required to sustain them.

### 2.6.3.1.3 Strategy and Tactics

The most important source for Anglo-Saxon tactics is the Song of the Battle of Maldon (Brown, 1995, p. 93). It has been generally accepted that the tactics described in the poem were employed during the late tenth century as well as beyond. In the poet's own words, "He commanded that with the shields they form the phalanx, and that the company hold out firm against the fiends" (*BM*, p. 23). This statement is believed to be in reference to the Anglo-Saxon shield-wall (Brown, 1995, p. 93).

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<sup>33</sup> The concept is also discussed with respect to Anglo-Norman armies in the twelfth century and English armies in the fourteenth and fifteenth centuries (Oman, 1924, p. 34; Lavelle, 2010, pp. 134-5; Morillo, 1994, pp. 169-70).

From the current literature, many of the key works on the Battle of Hastings have examined the Anglo-Saxon military strategy and tactics. For example, Lawson discusses possible Anglo-Saxon defensive structures at Hastings (2003, pp. 150-2). In Lavelle's book, he discusses the natural landscape in relation to strategies and scouting (2010, pp. 186-90). He also considers encampments and mobility of an army based upon offensive and defensive strategic aims (Lavelle, 2010, pp. 190-3 and 197-200).

For his part, Hooper has written on the king's bodyguards, or Housecarls, and the Anglo-Saxon navy in the eleventh century (1992b; 1992a). In the article pertaining to the Housecarls, Hooper indicates that they appear after 1016, and he compares them to the *Jomsvikings* who are believed to have had links to Denmark (Hooper, 1992b, pp. 1-3 and 8-9).<sup>34</sup> In the naval article, Hooper examines the concept of *scipfyrd*, or ship service (Hooper, 1992a, pp. 22-4). This article is also reprinted in the naval chapter of Lavelle's book on the Anglo-Saxon military (2010). Strategy and tactics are further discussed with reference to question 5 on the mapping of the battle in Chapter 7.

### 2.6.3.2 Norman

Two important books have recently been published on the Norman military. The first is Morillo's *Warfare under the Anglo-Norman Kings* (1994). Morillo's discussions pertaining to battles revolve around important concepts such as the goals of armies, movement, resources, leadership, and the age of cavalry. The book is clearly organized and presented, thus making it an excellent resource on the military organization of the period (Morillo, 1994). While there are references to Hastings, Morillo's book primarily covers the period following 1066. Therefore, relevant details from pre-conquest Normandy may have been excluded from his study.

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<sup>34</sup> This reference was originally published as Hooper, N. (1985). The Housecarls in England in the Eleventh Century. In *ANS*, VII, 167-76. However in this study, the reference will be from a reprint: Hooper, N. (1992b). The Housecarls in England in the Eleventh Century. In M. Strickland, *Anglo-Norman Warfare: Studies in Late Anglo-Saxon and Anglo-Norman Military Organization and Warfare* (pp. 1-16). Woodbridge, UK: The Boydell Press.



An edited volume by Strickland covers Anglo-Norman warfare from the late Anglo-Saxon period until the late twelfth and early thirteenth centuries (1992). This book contains some overlap with articles in Morillo's edited volume on the Battle of Hastings (1996). These articles include Brown's work on the Battle of Hastings (1996), Chibnall's work on pre-conquest Norman military service (1996)<sup>35</sup>, and Gillingham's work on William (1996).<sup>36</sup> The discussions presented by these authors are essential to our understanding of the Norman military during this period.

Brown can be considered one of the key authors on addressing the Norman military tactics. In his works Brown "reassert[s] the superiority of Norman military techniques over those of Anglo-Saxon England, defend[s] the professionalism of the Norman knights, and polish[es] the heroic image of Duke William to high gloss" (Morillo, 1996, p. 195). Another author who writes favourably of the Norman military tactics and their continental allies is Bachrach. His article describes the feigned retreats at Hastings where he indicates that even the flight of the Bretons was potentially feigned (Bachrach, 1996, p. 193).<sup>37</sup> Bachrach also wrote favourably of Duke William and the Normans' administrative capabilities in his article on military organization and resources (1985).

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<sup>35</sup> This reference was originally published as Chibnall, M. (1982). Military Service in Normandy before 1066. *ANS*, V, 65-77. However in this study, the reference will be from a reprint: Chibnall, M. (1996). Military Service in Normandy before 1066. In S. Morillo, *The Battle of Hastings: Sources and Interpretations* (pp. 80-92). Woodbridge, UK: The Boydell Press. The study has also been reprinted as: Chibnall, M. (1992). Military Service in Normandy before 1066. In M. Strickland, *Anglo-Norman Warfare: Studies in Late Anglo-Saxon and Anglo-Norman Military Organization and Warfare* (pp. 28-40). Woodbridge, UK: The Boydell Press.

<sup>36</sup> This reference was originally published as Gillingham, J. (1989). William the Bastard at War. In *Studies in Medieval History presented to R. Allen Brown*, eds. C. Harperbill, C. Holdsworth, and J. L. Nelson (Woodbridge, UK) pgs. 141-58. However in this study, the reference will be from a reprint: Gillingham, J. (1996). William the Bastard at War. In S. Morillo, *The Battle of Hastings: Sources and Interpretations* (pp. 96-112). Woodbridge, UK: The Boydell Press. The study has also been reprinted as: Gillingham, J. (1992). William the Bastard at War. In M. Strickland, *Anglo-Norman Warfare: Studies in Late Anglo-Saxon and Anglo-Norman Military Organization and Warfare* (pp. 143-60). Woodbridge, UK: The Boydell Press.

<sup>37</sup> This reference was originally published as Bachrach, B. (1971). The Feigned Retreat at Hastings. In *Mediaeval Studies*, 33, 344-7. However in this study, the reference will be from a reprint: Bachrach, B. (1996). The Feigned Retreat at Hastings. In S. Morillo, *The Battle of Hastings: Sources and Interpretations* (pp. 190-3).

### 2.6.3.2.1 Organization

Several works deal expressly with the organization of the Norman military at the time of the Battle of Hastings (Chibnall, 1996; Prestwich, 1992a; Prestwich, 1992b).<sup>38</sup> Prestwich wrote two important articles on the Norman military. The first article examines the finances, while the second focuses on the *familia regis*, the household of the king. One of the earliest mentions of the *familia* is from 1069 by Orderic Vitalis; therefore the concept might have been applicable to the Hastings campaign, which took place only three years earlier (Morillo, 1994, pp. 64-5).

Chibnall's article focuses on military service in Normandy before 1066. This article indicates that feudalism had not developed in Normandy to the extent that was originally thought; thus placing limitations on the Norman army's ability to draw on landowner contributions as occurred in England (Chibnall, 1996, p. 81; Morillo, 1996, p. 79). This finding has implications for the discussion of the Norman's ability to raise troops which is the focus of question 1 in Chapter 4.

Another important discussion has centred on the administrative boundaries of the time, such as the *pagi* or *vicomtes*, which can be traced back to the Carolingian era (Chibnall, 2006; Brown R. A., 1985b; Crouch, 2002; Neveux, 2008). There are also boundaries known as *pays* which were derived from the *pagus* (Neveux, 2008, p. 45).<sup>39</sup> They are mentioned by Wace and are depicted on eighteenth century maps (Van Houts E. M., 1987, p. 162; Delisle, 1716). However, the *pagus* or *pays* have not been related to the Norman military organization to the same extent as the shire has been to the Anglo-Saxon

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<sup>38</sup> The original reference is Prestwich, J. O. (1954). War and Finance in the Anglo-Norman State. *Transactions of the Royal Historical Society*, 5<sup>th</sup> series, IV, 19-43. However, the references will be to the reprint as: Prestwich, J. O. (1992a). War and Finance in the Anglo-Norman State. In M. Strickland, *Anglo-Norman Warfare: Studies in Late Anglo-Saxon and Anglo-Norman Military Organization and Warfare* (pp. 59-83). Woodbridge, UK: The Boydell Press. The second original reference is: Prestwich, J. O. (1981). The Military Household of the Norman Kings. *English Historical Review*, 96, 1-37. However, the references will be to the reprint: Prestwich, J. O. (1992b). The Military Household of the Norman Kings. In M. Strickland, *Anglo-Norman Warfare: Studies in Late Anglo-Saxon and Anglo-Norman Military Organization and Warfare* (pp. 93-127). Woodbridge, UK: The Boydell Press.

<sup>39</sup> "Pagi is the plural of *pagus*. The French word *pays* comes from this Latin term" (Neveux, 2008, p. 225).

military organization (Hollister, 1962; Abels, 1988; Lavelle, 2010). One exception is a brief article on geographic origins of William's army which presents some useful maps and findings (Hewitt, 2010).

Another focus in the literature is the main military unit for the Normans, the *conroi*, which consisted of ten or more men (Chibnall, 1996, p. 81; Lawson, 2003). In documents the mounted knights were termed *miles* or *milites* (Brown R. A., 1992).<sup>40</sup> There is also a variation in the status of knights from "common" to "noble" knights (Barthelemy, 2009, pp. 224-5). This variation is mentioned by *WP* and William of Jumièges in their accounts of the battle (Chibnall, 1996, p. 83). The terms are also used in reference to the Anglo-Saxon military (Abels, 1988, p. 132). Therefore, similar terms were employed by both sides of the Norman Conquest. These aspects of Norman military organization are discussed further in addressing question 1 in Chapter 4.

#### 2.6.3.2.2 Army Size

Sources present significant variation in assessing the size of William's army at the Battle of Hastings. The most common estimates are around 7000 to 8000 men; however, numbers range from as low as 5000 to as many as 14000 (Lawson, 2003, pp. 176-8; Huscroft, 2009, p. 121). Similarly to the English, army size could have a religious or poetic connection (Halsall, 2003, p. 121). There has also been some speculation as to the number of horses in the Norman army which is estimated at between 2000 and 3000 (Bachrach, 1985; Bradbury, 1998; Lawson, 2003; Gillmor, 1996; Fuller, 1996).<sup>41</sup> This estimate could be higher still as a knight and his squire would require one warhorse and

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<sup>40</sup> The original reference is: Brown, R. A. (1984). The Status of the Norman Knight. In *War and Government in the Middle Ages*, eds. J. Gillingham and J. C. Holt (Woodbridge) pp. 18-32. However, the references will be to the reprint at: Brown, R. A. (1984). The Status of the Norman Knight. In M. Strickland, *Anglo-Norman Warfare: Studies in Late Anglo-Saxon and Anglo-Norman Military Organization and Warfare* (pp. 128-42). Woodbridge, UK: The Boydell Press.

<sup>41</sup> The original reference is: Gillmor, C. (1984). Naval Logistics of the Cross-Channel Operation, 1066. *ANS*, VII, 105-31. However, the references will be to: Gillmor, C. (1996). Naval Logistics of the Cross-Channel Operation, 1066. In S. Morillo, *The Battle of Hastings: Sources and Interpretations* (pp. 114-28). The second original reference is: Fuller, J. F. C. (1954). *A Military History of the Western World*. (Minerva Press), pp. 374-82. However, the references in this study will be to: Fuller, J. F. C. (1996). The Battle of Hastings, 1066. In S. Morillo, *The Battle of Hastings: Sources and Interpretations* (pp. 166-71).

three supporting horses. As it is likely the squires fought in the battle as well, the total number of horses could be double the reported figure (Davis, 1987, p. 79; Morillo, 1994, p. 80). The size of the horses seems to also vary, with some authors indicating 14 hands and 1300 pounds and others for smaller sizes around 10 to 12 hands (Davis, 1987, p. 80). In another study, Davis indicates that eleventh century warhorses were small enough for some riders to touch the ground with their feet (1989, p. 21). Similarly to the Anglo-Saxon section, this evidence is important for question 1 as discussed in Chapter 4 as a check to ensure the army size estimate is reasonable. These values are also relevant to question 3 as discussed in Chapter 6 as the number of men and horses will dictate the amount of resources required.

### 2.6.3.2.3 Strategy and Tactics

In the literature, much is written about the Normans and in particular the mounted knight. In a study on Agincourt, it was estimated that in a charge the mounted knights could obtain speeds of 12 – 15 miles per hour or 19 – 24 kilometers per hour (Keegan, 1976, p. 95). Chibnall wrote several useful articles exploring the pre-conquest Norman military and particularly the use of mercenaries in the early twelfth century (1996; 1992). In yet another study, Gillingham examines William's style of generalship and then discusses the Norman Conquest with respect to eleventh century warfare in general (1996, p. 97).

There have been a number of discussions pertaining to the distribution of Duke William's forces in England before the battle. For example, several authors have indicated that William left some men to guard the camp and ships, thus reducing the size of his battle army (Lawson, 2003, pp. 176-8; Bachrach, 1985; Barclay, 1966, p. 72).<sup>42</sup> This point is important because the approximate number of garrison guards need to be accounted for in any discussion of the resources available to the armies at the time of the battle. The number of garrison soldiers could also have strategic implications. For example, beyond the requirements of life (food and water), these soldiers could have been called up to

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<sup>42</sup> Several of the sources make reference to a fortification which was likely manned. *WP* makes a specific reference to the guards of the ships (117-119).

replace fallen Norman soldiers during the battle. This discussion is further developed in addressing question 5 in Chapter 7 on mapping the battle.

#### 2.6.4 Landscape of the Battle

Landscape features are explored by the majority of the accounts of the battle. Lawson, for example, examines various elements such as the shape, soils, ponds, and woods (Lawson, 2003, pp. 50-4). The landscape is also discussed by Bradbury who, like Lawson, discusses the topography and relates it to the English formation (1998, pp. 132-7; Lawson, 2003, pp. 142-6). Bradbury further indicates that on some parts of the battlefield the natural local grasses grow much as they did at the time of the battle (Bradbury, 1998, p. 142). There is also a small, detailed booklet about the battle which includes a map of topographic and modern features (Lemmon, 1970). Brown's article presents a detailed topographic map drawn in the early 20<sup>th</sup> century of the battlefield with the units presented (1996, pp. 198-9). This map has been employed by several authors since Brown in their discussion of the battle (Lawson, 2003; Wood, 2009).

Within popular historical sources, there have also been limited 3-D representations of the battle which attempt to present the basic elements of the natural landscape and unit formations. One such example is discussed in Gregory and Ell's book on historical geographical information systems (Gregory & Ell, 2007, pp. 110-2). Another example presents the battle in several stages in detailed maps (Gravett, 1992, pp. 70-1).

The key source for the natural and human features on the battlefield is undoubtedly the *BT*. In the tapestry, there is a hill and a watercourse (Stenton, 1965, pp. Plates 66-7; Lawson, 2003).<sup>43</sup> An historical human feature is Battle Abbey which was begun on the site of the battle in the 1070s.

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<sup>43</sup> The scenes of the *BT* may in fact be artistic rather than actual as "there are figures that are so close to others found in English eleventh-century . . . [manuscripts] that those in the Tapestry look like modifications of the same models" (Wormald, 1965, p. 32). It has also been suggested that the design was based on the column of Marcus Aurelius in Rome.

As regards to the location of the battle, historians have expressed much uncertainty. This point was acknowledged by Huscroft in his work on the Norman Conquest where he claimed the battlefield provoked as many questions as answers (Huscroft, 2009, p. 126). Specifically, the exact location has been questioned as there have been no archaeological finds which would suggest a major battle at the site (Grehan & Mace, 2012, pp. 141-4). This debate originated soon after the time of the battle itself. One perspective examines the location of the high altar while another focuses on the location itself (Bradbury, 1998, pp. 129-31; Lawson, 2003, p. 50). A third perspective surrounds the topography. This discussion is explained by Hare, who indicates that the modern landscape has “little relation to the much steeper one up which the Norman cavalry would have had to charge” (Lawson, 2003, p. 50; Hare, 1980, p. 80).

An additional discussion related to landscape revolves around the name of the hill. Specifically, authors discuss the name Senlac and examine its origins and meaning which is “sand-lake” (Lawson, 2003, pp. 56-7; Bradbury, 1998, p. 133). Some have said the name is Old English derived from the local sandy streams while others believe it is Old French (Lawson, 2003, pp. 56-7; Bradbury, 1998, p. 137).

Another key uncertainty surrounds the location of the *Malfosse* where the English made their last stand as mentioned by the historical sources at the end of the battle. This debate has been discussed by several historians of the battle. It is believed to exist behind Caulbec Hill but there is some controversy (Bradbury, 1998; Lawson, 2003; Wood, 2009; Brown, 1996).

Thus, there have been several debates regarding the Hastings Battlefield. These discussions have focused on the location of the battle and associated place-names. They have also focused on the topography of the region. These debates and discussions form the basis for consideration of research questions 4 and 5 in Chapter 7.

### 2.6.5 Key Stages of the Battle

In terms of timelines, sources generally accept that the battle began at approximately nine in the morning with an arrow volley, followed by attacks by Norman infantry and knights

(Bradbury, 1998; Lawson, 2003; Morillo, 1996). It was at this point some of the Norman force believed William was dead and the army began to disintegrate. This crisis precipitated a key event in the battle, as the Anglo-Saxons now possessed the advantage and even pursued the remnants of the Norman army (Bradbury, 1998, p. 145). However, sources also indicate Duke William rallied his men and soundly defeated the pursuing Anglo-Saxons. This stage is famously depicted in the Bayeux Tapestry (Plate, 68) and written about by *WP* and in the *CHP* (Morillo, 1996, pp. xxvi-xxvii, 13 and 48; Stenton, 1965, p. Plate 68).

Following the Norman recovery, most accounts suggest that there was a regrouping and a break in the fighting possibly to pass food around (Wood, 2009, pp. 187-8). When the fighting resumed it was described by a number of historians as “unusual”, owing to its length. Where medieval battles were typically seen as short (Morillo, 1990, pp. 95-6), the fighting at Hastings lasted well into the evening, ending at around dusk. The fighting at this point consisted of Norman attacks, retreats and breaks. Towards the end of the day, it is believed Harold received an “arrow in the eye” (Morillo, 1996, p. xxix). However, even this theory has been debated as the *BT* was restored in the nineteenth century and was not necessarily accurate (Lawson, 2003, pp. 226-32). Following Harold’s death the Anglo-Saxon army collapsed and, as most historians indicate, made a final stand at a location of the battle known as the *Malfosse* (Lawson, 2003, p. 234).

## 2.6.6 Cartographic Representations of the Battle

There have been many cartographic representations of the battle.<sup>44</sup> The most respected depiction is by General E. Renouard James from 1909 (Brown R. A., 1996, pp. 198-9; Baring F. M., 1909). This map has been reprinted in several key works on the Battle of Hastings including the works of Brown (1996), Lawson (2003) and Wood (2009). The map also appears to be the basis for Morillo’s maps of the Battle of Hastings in his edited work on the battle (1996). Therefore, it would be relevant to consult this map in any

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<sup>44</sup> A number of these may be viewed at: <http://www.battlefieldtrust.com/resource-centre/viking/battleview.asp?BattleFieldId=17>.

analysis of the battle. Other cartographic depictions are presented in Bradbury's work on the battle (1998, pp. 139-41) and Lawson has reproduced Freeman's (2003, p. 139; Freeman, 1875) and Ramsay's (2003, p. Plate 36; Ramsey, 1898) maps of the battle. Additionally, there have been some modern cartographic depictions. However, these are purely heuristic and lack any real analytical content (Gravett, 1992; Kimerling, Buckley, Muehrcke, & Muehrcke, 2009). Current mapping techniques, as will be undertaken in Chapter 7, provide the ability to produce more detailed and advanced cartographic depictions of the battle, thus, demonstrating the importance of geography in re-interpreting key historical events.

## 2.6.7 Aftermath

The events of the campaign following Hastings until the coronation of William in December 1066 are generally accepted by historians of the period. Following the battle, the dead were buried but there has been a mystery as to exactly what happened to Harold's body. Historians generally believe that William wanted his treatment in death to be as basic as possible to prevent the development of cults (Bradbury, 1998, p. 156). It is believed that Duke William waited in Hastings for the Anglo-Saxons to submit, however, they did not and instead supported another claimant to the throne, Edgar the Ætheling (Higham, 1997, pp. 213-5). Realizing that the Anglo-Saxons were not ready to submit, William marched to Dover (Bradbury, 1998, p. 157). This maneuver was intended to secure the south before moving onto London (Bradbury, 1998, p. 155). Bennett, in his book on the Norman Conquest, provides several excellent maps including a detailed map of the march to London. This map includes the route of the army, stopovers, and raids (Bennett M. , 2001, p. 47). The Anglo-Saxons abandoned Edgar the Ætheling and officially submitted at Berkhamsted (Lawson, 2003, p. 243; Higham, 1997, pp. 218-219). Duke William was crowned on Christmas Day 1066 as King William I of England.<sup>45</sup>

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<sup>45</sup> Charlemagne was crowned as the Roman Emperor on Christmas Day in A.D. 800. It has been suggested that William may have been trying to emulate Charlemagne's legitimization of power. For more on Charlemagne, see Bennett & Hollister's brief introduction to the man and a subsequent bibliography (2006, pp. 104-118).



In the following years there were several revolts such as Exeter in 1067-8 (Bennett M. , 2001, pp. 49-51), The Harrying of the North in 1069-70 (Higham, 1998, p. 76) and the campaign of Hereward the Wake in the Isle of Ely in 1070-1 (Bennett M. , 2001, pp. 57-60). However, all of these revolts were successfully defeated (Bennett M. , 2001; Barlow, 1988; Huscroft, 2009).

According to historical accounts, there were several key consequences of the Norman Conquest. The first was the loss of leadership in England because “the deaths of Harold and his brothers, Leofwine and Gyrth . . . removed the figures around . . . [which] the regime was constructed” (Higham, 1998, p. 53). Therefore, without effective leadership, the Anglo-Saxon state began to collapse (Higham, 1997, p. 213). The *thegns*, or land owners, who survived the Conquest fled to Byzantium and the Varangian Guard (Higham, 1997, p. 230). They were eventually replaced in England by the Anglo-Norman knights (Holt, 1992).<sup>46</sup>

Another major outcome of the Conquest was the *Domesday Book*. As was mentioned earlier, this document was compiled in 1085-6 due to the threat of a Danish invasion (Bennett M. , 2001, p. 69). Brown, citing Stenton, states that *Domesday* ““as an administrative achievement . . . [had] no parallel in medieval history”” (1995, p. 159). This record is in fact considered as one of William the Conqueror’s great achievements as king (Brown, 1995, pp. 158-9).

The key events following the battle are discussed in Bradbury (1998) and Lawson’s (2003) books on the battle. Similarly, the articles in Morillo’s book on the battle mention the events following the battle briefly, if at all (Brown R. A., 1996; Morillo, 1996; Bachrach, 1996; Glover, 1996; Fuller, 1996). For fuller accounts of the events following the battle, works which focus on the Norman Conquest should be consulted; a reliable starting point would be Bennett’s book on the Campaigns of the Norman Conquest

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<sup>46</sup> The original reference is: Holt, J. C. (1984). The Introduction of Knight Service in England. *ANS*, VI, 89-106. However, the references will be from the reprint as: Holt, J. C. (1992). The Introduction of Knight Service in England. In M. Strickland, *Anglo-Norman Warfare: Studies in Late Anglo-Saxon and Anglo-Norman Military Organization and Warfare* (pp. 41-58). Woodbridge, UK: The Boydell Press.

(2001). In this book, the various campaigns to suppress rebels in England are discussed and mapped in detail (Bennett M. , 2001). For more detailed analyses, Huscroft's book provides some important details on the period (2009). The general impacts of the conquest are dealt with in several works. Chibnall's work on Anglo-Norman England is an effective and detailed overview of the period from 1066 until 1166 (1986). She includes discussions in particular on government and society (1986). Another detailed account is Barlow's work on England in the eleventh and twelfth centuries (1988). However, unlike Chibnall, he brings the perspective of the late Anglo-Saxon state with a discussion on the reign of Edward the Confessor (Barlow, 1988). Mason's work explores themes in government from late Anglo-Saxon times until the reign of Richard I (2002). She discusses the 900<sup>th</sup> anniversary of the *Domesday Book* (Mason, 2002, pp. 143-4) as well as the content of the survey itself (Mason, 2002, pp. 144-8). With respect to knights in Norman England, Holt provides an effective overview of the subject (1992). He also discusses the concept of quotas of knights from the various landholders (Holt, 1992, pp. 51-2). Harper-Bill's work is another source on the period focusing on the evolution of the Church from the Anglo-Saxon to Norman period (2002). Church architecture at the time of the battle with respect to the *Domesday Book* is examined by Brown (1965). Changes in church architecture in the period from Romanesque to Gothic are also dealt with by several authors (Plant, 2002).

This battle was a reflection of the times in which it was fought. These books and articles are important to understanding the battle as they reflect this period. Additionally, the articles on church architecture could prove especially relevant in examining the changes to the topography of the battle site with the construction of Battle Abbey following 1066.

## 2.7 Conclusions

In conclusion, this chapter has presented summaries of the numerous sources employed to date in studies of the battle. Historically, these sources range from the time of the battle until the modern era. They include written documents, works of art as well as cartographic depictions and environmental studies. The chapter has also demonstrated what is known about the lead-up to the Battle of Hastings, the battle itself and the aftermath of the battle. It has covered the organization, army size, tactics, the events of

the battle, and its aftermath. Sources regarding the landscape of the Battle of Hastings were examined as well as a limited number of cartographic depictions of the battle.

Ultimately, this chapter has indicated the sources and what is known about the battle. Gaps in the literature have also been identified. A selection of these gaps will be explored in this study, primarily through the application of geographic analysis. These are linked to the research questions developed in Chapter 1 and include four main areas of interest: the size and composition of the armies, the local landscape, the resources available to the armies, and location of the battle. Specifically, a detailed cartographic analysis will look at how the armies were assembled in response to question 1 in Chapter 4. In addressing question 2 in Chapter 5, a time-based cartographic analysis of land use together with environmental modeling assesses the likely condition of the battlefield and its transformation to the present day. Detailed mapping along with a table-based model considers the local resources at the time with regards to question 3 in Chapter 6. Finally, with respect to questions 4 and 5, the study contributes to debates concerning the location of the battle, by suggesting the two most likely candidates in Chapter 7. However, before conducting these analyses, an overview of the methodological frame work for this study will be presented.

## Chapter 3

### 3 Geographical Research Methods for Medieval Studies: A Review of Techniques

In this chapter, a series of methodological approaches that can be applied to studies of the medieval historical context are reviewed. The chapter concludes with a discussion of which of these are most appropriate to this study and how and where they will be employed.

The medieval world can in fact be studied from a variety of perspectives. One such perspective that is highly relevant to the period, and to the present study, is a geographic one. For an ideal geographic study, it is best to examine both the natural and cultural landscapes (Christopherson, 2004; Knox, Marston, Imort, & Nash, 2013). However, several linguistic medievalists have ignored or dismissed the natural landscape as not relevant to their period (Williamson, 2013, pp. 3-5). One may argue that this restricted view is not rooted in a lack of knowledge, but by the fact that geography is increasingly seen as more quantitative and technical (given, for example, the development of geographic information systems [GIS]) and thus less relevant to history with its focus on the written record. In response to these perceptions, what may be needed is a more practical approach to GIS that might be specifically tailored to the needs of medievalists and complement a more qualitative focus. This perspective would allow students of medieval history to expand their focus to better:

understand [the] basic physical systems that affect everyday life . . . [, conceptualize the role of geography] in the evolution of people, their ideas, places and environments . . . [and] make sensible judgments about . . . [the] relationships between the [natural] physical environment and society (Knox, Marston, Imort, & Nash, 2013, p. 6; The Royal Canadian Geographical Society, 2014).

The benefit of such “mixed methods” approaches (Elwood & Cope, 2009, p. 4) is that they “weave together diverse research techniques to fill gaps, add context, envision multiple truths, play different sources of data off each other, and provide a sense of both the general and the particular” (Elwood & Cope, 2009, p. 5). Such approaches would

further allow researchers to use the landscape as a source itself and as a framework to organize their thoughts (Rippon, 2004, p. 3). The optimal method for studying these concepts is with GIS.

Based upon these methodological observations, there are several specific objectives of this chapter. These are to: 1) discuss the current state of Historical GIS and the benefits of GIS to medieval studies specifically, 2) illustrate how to bring medieval documents into GIS, 3) provide a brief overview of both qualitative and quantitative techniques in human and physical geographic research; and 4) present how these methods will be incorporated into addressing each of the five research questions in this study.

### 3.1 Historical GIS

The ideas and theory behind GIS technology have existed since the 1960s, whereas the software has been in existence since the 1980s (Gregory & Ell, 2007, pp. 12-3). The use of GIS in historical applications has been present since the 1990s (Gregory & Ell, 2007, pp. 15-6). The main discussion of Historical GIS is Gregory and Ell's book on the subject which weaves the basics of GIS together with a discussion of the theories and examples of previous Historical GIS studies (2007). A complement to this study is Sherry Olson's research on Montreal with Robert Sweeny and Jason Gilliland (Sweeny & Olson, 2003). This research is the foundation of historical GIS studies in Canada (Bonnell & Fortin, 2014, pp. xii-xiii). There are also journal issues and edited books on the subject which provide essays by experts on the use of historical GIS in their research (Gregory & Ell, 2007, p. 16). These include special issues in *Historical Geography*, *History and Computing* and *Social Science History* (Gregory & Ell, 2007, p. 16) as well as two books assembled by Knowles (2002; 2008) and one by Bonnell and Fortin on Historical GIS in Canada (2014). Gregory has also helped assemble a broader collection of historical GIS studies across the field in an edited book (Gregory & Geddes, 2014).

This section will present a brief description of specific applications of Historical GIS. These applications are taken from a variety of fields including environmental history, historical mapping, literary GIS, historical military studies and urban studies.

With respect to applications of GIS to environmental history, there are a number of examples of studies which rely upon GIS. One study examines a settlement and land ownership in Colonial America (Donahue, 2008). Another looks at land ownership and agriculture in a village in the British Isles (Pearson & Collier, 1998; Pearson & Collier, 2002). In these two studies, an emphasis is placed on the individual fields of a village and on land ownership. Another environmental study examines dust storms in the middle of the continental US during the late nineteenth century and early twentieth century (Cunfer, 2002; Cunfer, 2008). In Cunfer's 2002 study, he revealed a link between the storms and cropland, water availability and temperature (Cunfer, 2002, pp. 97-100). Novak & Gilliland (2009), examined the role of the local topography in contributing to the 1883 flood in London Canada. They estimated the extent of the flood with several rises in river levels from 2 to 8 m (Novak & Gilliland, 2009). The findings were compared to the contemporary historical records about the flood. Citizens' reactions and relocations after the flood were also depicted cartographically (Novak & Gilliland, 2009).

With regard to historical mapping, still other examples exist. Elliott & Talbert have prepared a unique digital atlas of the ancient world (2002). There is also the *Digital Atlas of Roman and Medieval Civilizations* (McCormick, et al., 2013) which looks at the Roman and Medieval periods in some detail with multiple cartographic sources. However, in both cases there is little spatial analysis conducted with places or roads simply plotted on a map.

The use of literary GIS is discussed in a number of places (Gregory & Cooper, 2009; Gregory & Geddes, 2014; Lafreniere & Gilliland, 2015; Travis, 2015; Bodenhamer, Corrigan, & Harris, 2010; Yuan, 2010). Specifically, the field is exemplified by Gregory and Cooper's study on two nineteenth century descriptions of the Lake District in the UK (2009). Lafreniere & Gilliland examined personal time-space in nineteenth century London Canada through qualitative and quantitative sources and techniques (2015). This study mapped, for example, students' journeys to school in the 1880's (Lafreniere & Gilliland, 2015, p. 234). There was also a detailed mapping of individual diaries and how location was important in their day to day activities (Lafreniere & Gilliland, 2015, pp. 237-41). In this study, similar to the two studies mentioned above, the documents were

mapped out in detail and analyzed based on how the writers were experiencing the local terrain at the time.

To date, historical military GIS applications have been utilized to analyze the American Civil War. Lowe has mapped and performed a selection of basic spatial analyses on a number of battlefields including ones at the Fredericksburg-Spotsylvania National Military Park Virginia, Petersburg National Battlefield Virginia, Bentonville Battleground State Historic Site North Carolina, Stones River National Battlefield Tennessee and Chickamauga National Military Park Georgia (Lowe D. W., 2002). However, none of these examples details the course of a battle. Knowles et al.'s, viewshed analysis of the Battle of Gettysburg from 1863 provides a detailed look at a battlefield (2008). This research focused on a known battlefield with multiple cartographic sources including a detailed topographic map drawn a decade following the battle (2008, pp. 244-8). The framework of that study, informed in part the analyses conducted in Chapter 7 of this study, particularly with respect to topography and what was visible from certain locations over the battlefield.

With respect to the application of GIS to urban studies, research has explored a number of trends such as immigration to New York (Beveridge, 2002), residential sales in Philadelphia (Hillier, 2002), retailing in London Canada (Novak & Gilliland, 2011), and segregation in Montreal (Gilliland, Olson, & Gauvreau, 2011). London Canada is also detailed as discussed above by Novak & Gilliland (2009) and Lafreniere & Gilliland (2015). There is also an online database project, "Montréal's MAP: Montréal l'avenir du passé" (Sweeny & Olson, 2003), which explores changes in Montréal's urban landscape during the nineteenth century.

In general, these studies have presented examples of historical scholarship through a geographic perspective. They have also demonstrated that much can be accomplished by mapping and spatially analyzing historical data; however, gaps still exist. Specifically, environmental history studies do not typically include erosion modeling which could prove useful in understanding an historical landscape. Another gap in historical GIS studies is that beyond the seventeenth century, most projects simply map their periods

and do not provide much in the way of spatial analysis which could contribute to our knowledge of those periods. In terms of literary GIS, the number of times specific geographic terms were recorded in the literature is important, yet has not been fully addressed (Bodenhamer, Corrigan, & Harris, 2010; Travis, 2015; Yuan, 2010). This information could be relevant because it would indicate the importance of a geographic term to the authors of the time. Finally, military studies primarily focus on the battlefield; yet, there is more to a military campaign than just the battle. In order to fully understand the conflict, researchers must consider the mobilization and resources as well. Such drawbacks will be further discussed in Chapter 8 as well as the ways in which this study seeks to address them. Specifically, this study considers and expands upon the techniques discussed above and undertakes a more rigorous analysis further back into history than previously in the absence of detailed maps or firsthand accounts.

## 3.2 Theory, Benefits and Limitations of GIS

In employing GIS in the historical context, as is undertaken in this study, it is important to understand the overall theory and benefits of the approach. A GIS is a “[c]omputer-based system to aid in the collection, maintenance, storage, analysis, output, and distribution of spatial data and information” (Bolstad, 2005, p. 1).<sup>1</sup> GIS represents the world as either pixels in raster data or as points, lines and polygons in vector data (Bolstad, 2005, pp. 30-3; Gregory & Ell, 2007, p. 23). Examples of both are presented in Figure 3.1. Figure 3.2 depicts a basic example of the structure of vector data with a map file (cartographic data) and a table (tabular data) which contains multiple variables.<sup>2</sup> The rows are referred to as records, while the columns are attributes (Bolstad, 2005, p. 267). Raster data on the other hand represent one variable (Bolstad, 2005; Gregory & Ell,

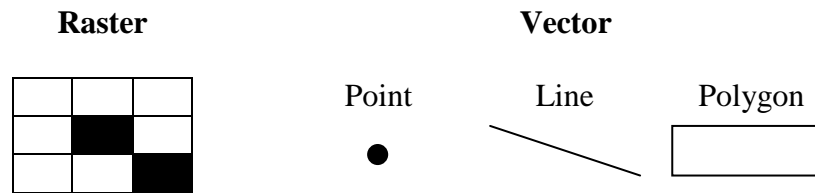
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<sup>1</sup> A GIS also “combines a database management system (DBMS) with a computer mapping system” (Gregory & Ell, 2007, p. 3). Gregory and Ell, *Historical GIS* is the main study on historical GIS however, it is more philosophical and less focused on doing GIS-based analysis than say Bolstad, *GIS Fundamentals*. A more scientific study of GIS would focus on coordinates, surveyed data and geometry. Statistics are also essential in GIS studies. When considering a GIS project have a look at a basic GIS textbook.

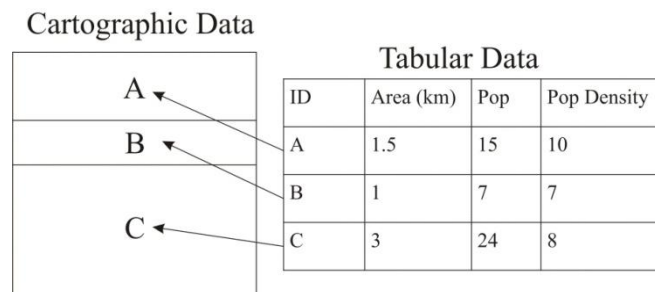
<sup>2</sup> The cartographic file is defined by coordinates which are either geographic i.e. latitude / longitude or they are displayed through a coordinate projection. For more on projections see: *GIS Fundamentals*, chapter 3 (Bolstad, 2005) or chapters 3 and 4 in *Map Use* (Kimerling, Buckley, Muehrcke, & Muehrcke, 2009).



2007). This distinction is important because how GIS represents the data, or what it represents, can have an impact on the types of analysis conducted. It can also influence the interpretation. In this thesis, both raster and vector data will be employed based on the desired analysis (Bolstad, 2005; Gregory & Ell, 2007).



**Figure 3.1: Raster and Vector GIS Data Models<sup>3</sup>**



**Figure 3.2: The Basic Structure of Vector Data**

Research projects in general can benefit from GIS for three main reasons (Kemp, 2009). The first is the ability to bring several pieces of both qualitative and quantitative data together in a single file or database (Gregory & Ell, 2007, pp. 9-10). For example, for a single location we can record several facts such as area, population, and population density (see Figure 3.2). Thus maps and data can be generated efficiently as well as effectively distributed.

The second benefit of GIS is its acceptability as a research tool / method (Knowles, 2008; Gregory & Ell, 2007, pp. 10-1). For example, in GIS, information and its pitfalls can be effectively analyzed with statistically based solutions (Gregory & Ell, 2007, p. 82). GIS can also “devise new analytical techniques that make use of the advantages of spatial data

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<sup>3</sup> This figure is based upon diagrams in other GIS texts (Bolstad, 2005, p. 31; Gregory & Ell, 2007, pp. 24-8).

while being sympathetic to their limitations” (Gregory, 2008; Gregory & Ell, 2007, p. 11). Therefore, GIS is more than just an organizational tool, it provides analytical statistical framework for the analysis of variable spatial data such as those presented in this project.

The final advantage of GIS to be discussed here is its ability to display data effectively on a map (Bodenhamer, 2008). Examples of visualization include Gregory and Cooper’s article on literary GIS which employed the technology to link between the text and the map in the lake district of the UK (2009, pp. 79-80). This concept is also considered through historical web mapping of a town using *Google Maps* (Harris, Rouse, & Bergeron, 2010, pp. 135-7). Harris, Rouse, & Bergeron also explore *Google Maps* as a mode to share information with other interested researchers (2010, pp. 137-9). Therefore, GIS is an effective visualization tool as well, and overall, an ideal platform for analysis. However, what is the theory behind this approach? To answer this question, a brief discussion of grounded visualization follows.

Grounded visualization was selected as the theoretical approach behind this project because it can incorporate “the historical, geographical and cultural context” (Knigge & Cope, 2006, p. 2029). This approach can be defined as the intersection between “two analytical methods – grounded theory (based in qualitative research) and visualization (based on quantitative GIS)” (Knigge & Cope, 2006, p. 2024). Grounded theory is “theory derived from data in the course of a particular study” (Adler & Clark, 2003, p. 335). Visualization on the other hand is viewing the data in the form of art, diagrams, graphs and maps. In a research project, these two approaches complement each other because together they encourage exploration of the data, multiple data collection / examinations, a focus on the general and the specifics of the research question and finally, ongoing interpretations and reinterpretations of the data to fill the gaps in the literature (Knigge & Cope, 2006, p. 2028). For example, in terms of this study, in Chapter 4, the geopolitical context of England and Normandy is visualized and then spatially analyzed. This interpretation allows theories to be developed regarding how Harold and William assembled their armies. In Chapter 5, the land uses are visualized spatially together with the local topography. The RUSLE model is then calculated for a

variety of conditions and visualized spatially. These results consequently allow for interpretations to be presented regarding the amount of landscape change in the area. Chapter 6 then visualizes the resources cartographically and then theorizes about what the armies could have potentially accessed in the area. Chapter 7 then deduces the location of the battle from the geographic terms in the written accounts, as well as hypotheses about the battle from the written accounts and maps.

A number of historical GIS studies employ a grounded visualization approach. Pearson & Collier first examined, mapped and analyzed historical environmental data and then inferred conclusions about the village from the maps and analysis (1998). Novak & Gilliland visualized and then deduced interpretations about the 1883 flood in London Canada from flood analysis maps and historical records (2009). Gregory & Cooper mapped and spatially analyzed two diaries and then deduced interpretations about them (2009). Lafreniere & Gilliland mapped in detail the daily lives of people in late nineteenth century in London Canada (2015). From this analysis they were able to infer an interpretation and understanding of daily life at the time in that city (Lafreniere & Gilliland, 2015). In Knowles et al.'s landmark study (2008), her team drew conclusions about General Lee's decisions at the Battle of Gettysburg (1863) by visualizing his viewshed across the terrain. This knowledge led to the conclusion that Lee was unable to see a number of important areas of the battlefield and that this in turn contributed to a number of poor decisions on his part during the battle (Knowles et al., 2008). Finally, Novak & Gilliland visualized retail locations and trends in London Canada between 1844 and 1916 (2011). This research inferred through visualization, shopping trends with regards to location over an historical time period (Novak & Gilliland, 2011).

Some limitations to the GIS approach are also worthy of mention. One limitation is linguistic in nature. A modern geographer studying the medieval world would likely not be not in a position to analyze historical documents in the original Latin. At the same time, a through geographic analysis, as is undertaken in this study, is possible (Lilley, 2011, pp. 148-50). This is true insofar as by using geographic methods, the focus is on examining the landscape per se, which can be interpreted and analyzed using translated sources.

A second limitation is associated with the data itself and how the landscape is represented on a map. Correcting for ambiguity or uncertainty in an historical study can influence the subsequent analysis, and thus how the data in an historical map is integrated is just as important as developing the map itself. Two major debates with respect to formatting and imputing data are presented below.

### 3.3 Format and Input of Data

In this section, differences between local and global data will be explored, as well as different types of data and how they can be assessed. It is important to understand these distinctions as the various types of data available will obviously influence the types of analyses that can be conducted in this study. In the final section, techniques associated with data input and formatting will also be discussed.

#### 3.3.1 Local and Global Data

As part of any analysis, there is an important distinction between local and global data. Global data or aggregate statistics assume one value or rate for an entire area which is defined by a boundary. Conversely, local data represents the measurement at a specific location. This data is not aggregated and in statistical analysis is preferred over global values because the results will be more reliable. However, given the uncertainties of historical research, especially with the medieval period, a fine resolution “could lead one to the conclusion that we know more than we really do” (Heinen, 1998, p. 189; O'Sullivan & Unwin, 2010; Rogerson, 2010) about how the world appeared in the eleventh century. This reflection is important and should be considered when selecting the level of aggregation of the data which in turn influences cell size or resolution within a set boundary. However, even boundaries are debatable due to boundary changes or errors.

One important map based concept of boundary changes is the modifiable areal unit problem or MAUP. This concept focuses on aggregation to certain boundaries and how changes in the boundaries can influence the aggregation. Therefore, different boundaries would lead to different results in the analysis (Gregory & Ell, 2007; O'Sullivan & Unwin, 2010; Rogerson, 2010). Consideration of this observation is important for historical

research because the boundaries may change over time which could skew the results. Therefore, the boundaries to be considered must be accurate for the period under examination. Thus, in studies with aggregation, an examination of the boundaries would be essential for ensuring accuracy (Gregory & Ell, 2007, pp. 164-6; Kemp, 2010, pp. 35-7). For example, aggregating data to the hundred boundaries would more accurately reflect the spatial variation of a concept than to the shire boundaries.

Another similar challenge is presented by the ecological fallacy which concerns the implications of differences between individual and aggregate statistics. This distinction is important because if one trend is reported for a broader area, but the trend varies locally within that area, then the potential for error exists in interpreting spatial trends (Gregory & Ell, 2007; O'Sullivan & Unwin, 2010). Therefore, the level of aggregation is important when assessing trends (Gregory & Ell, 2007; O'Sullivan & Unwin, 2010). Thus, potential pitfalls in the data would have to be considered in further discussion and analysis.

### 3.3.2 Data Input

Beyond accessing modern data, there are two basic methods by which historical data can be transferred into a GIS. The first is qualitative and is based upon written documents, while the second is quantitative and is focused primarily with geo-referencing maps.

In the first case, data can be brought into a GIS from a set of written documents (Howell & Prevenier, 2001, pp. 60-8). This task can be achieved with some simple steps. First, one must consider some geographic minded questions. These could include references to places, climate, weather patterns, travel (to or from a destination), statistics, and topographic features (Baker & Butlin, 1973, p. 37). These can be highlighted in the texts and then a table constructed for each theme. An example from the literature is Lavelle who recorded places mentioned in the *ASC*. However, in this analysis, he did not consider recording the number of occurrences (Lavelle, 2010, pp. 202-7). Noting the number of occurrences can indicate the importance of a place, idea or concept. For example, if slope was mentioned in a text five times, then it is likely more important than a single mention of weather. An examination of the tables can then be used to identify

commonalities which allow for their consolidation. In Figure 3.3, reference A is common to all three and particularly important to source A. This evidence can also be mapped to locations B and D. Qualitative queries could then be conducted to see where certain concepts appear. Additionally, this data can be transferred into the quantitative analysis portion as the frequencies have been recorded.<sup>4</sup> In this study, the main example of this technique appears in Chapter 7 in response to question 4 regarding the location of the battle (Yuan, 2010).

Source A	Source B	Source C
Reference A (3)	Reference A (2)	Reference A
Location B	-	Location B
Reference C	-	Reference C (2)
Location D	Location D	-

**Figure 3.3: Theoretical Textual Data Input Record<sup>5</sup>**

Geo-referencing is the process of aligning historical maps with “an Earth-based map coordinate system” (Bolstad, 2005, p. 139). This analysis is typically conducted with a series of control points. GIS undertakes a point by point transformation which “employs linear equations to calculate [the resultant] map coordinates” (Bolstad, 2005, p. 144). The GIS then calculates the residual between the two points and summarizes the findings with a root mean square error (RMSE). These “[t]ransformations are often fit iteratively, and control points with large errors inspected, corrected, or deleted until an acceptable RMSE is obtained” (Bolstad, 2005, pp. 145-6).<sup>6</sup> Upon reaching an acceptable RMSE, the maps can be geo-referenced.

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<sup>4</sup> An excellent example of this technique but for one source is the website on the *Prosopography of Anglo-Saxon England* (Baxter & Jessop, 2010; King's College, London, 2010).

<sup>5</sup> This figure was developed by the author.

<sup>6</sup> For more detailed discussions of these transformations, see: *GIS Fundamentals* (Bolstad, 2005, pp. 144-5) or "Studying Cartographic Heritage: Analysis and Visualization of Geometric Distortions" (Jenny & Hurni, 2011, pp. 403-4).

## 3.4 Qualitative GIS Techniques

A qualitative technique focuses on “interpretations that can be captured in words rather than in variables and statistical language” (Adler & Clark, 2003, p. 456). One of the key benefits of qualitative data is “they are more likely to be grounded in the immediate experiences of . . . [the historical authors rather] than in the speculations of researchers” (Adler & Clark, 2003, p. 497). However, depending upon the size and scope of the study population, the accuracy of findings may be open to debate.

### 3.4.1 Sources

Qualitative historical sources “are artifacts that have been left by the past. They exist either as relics . . . or as the testimonies of witnesses to the past” (Howell & Prevenier, 2001, p. 17). In medieval research, sources are collected from archives and printed editions of written materials.<sup>7</sup> From these materials emerge the research focus and question. As indicated above, projects can either focus on these sources per se or the associated environment. In a source focused project, researchers would be selecting an historical document and producing a critical analysis of it with other supporting documents. Conversely, in environment focused research, the location becomes the main point of the project and sources are selected based upon the location. Either way, from this point, the data can be geographically analyzed in a GIS (see above) (Baker, 1997; Black, 2003, p. 478).

### 3.4.2 Data Reduction – Coding, Memos and GIS

Qualitative data reduction is “the various ways a researcher orders collected data . . . [this organization is] affected by the kinds of data you collect but is also affected by, and affects, the conclusions you draw” (Adler & Clark, 2003, p. 503). The two types of data reduction processes are “coding and memoing” (Adler & Clark, 2003, p. 503; Edhlund & McDougall, 2012). These processes can aid historians in their analysis of the sources.

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<sup>7</sup> For a discussion of available medieval sources, see: *Understanding Medieval Primary Sources* (Rosenthal, 2012).

One of the main historical methods involves comparing the sources often employing a set of seven rules (Howell & Prevenier, 2001, pp. 70-1). These rules basically indicate that the accurate representation of an historical event is based upon the number of reliable contemporary sources which have been written independently of each other (Howell & Prevenier, 2001, pp. 70-1). This process can be aided with coding because coding is “the process of associating words or labels with passages and then collecting similarly labeled passages into files” (Adler & Clark, 2003, p. 503) or tables. Similar to the data input section, the occurrences of the coded evidence should also be noted as this data will reflect the importance of the concepts. These codes are defined by memos which are “more or less extended notes that the researcher writes to help herself or himself [to] understand the meaning of codes” (Adler & Clark, 2003, p. 506). In the final version, these additional pieces of evidence could be considered in footnotes (Howell & Prevenier, 2001; Rampolla, 2004). From a geographic perspective, geographical minded questions should be asked, such as those posed in the introductory chapter of this project. These include where a concept is located and or how it varies from location to location.

In GIS, the main form of qualitative analysis would be through querying or selection. “*Selection operations* involve identifying features that meet one to several conditions or criteria” (Bolstad, 2005, p. 300). This ability allows researchers to search for a specific idea or concept in their database. The operations are known as set and Boolean algebra. “Set algebra uses the operations less than ( $<$ ), greater than ( $>$ ), equal to ( $=$ ), and not equal to ( $<>$ ) . . . [while] *Boolean algebra* uses the conditions OR, AND, and NOT to select features” (Bolstad, 2005, p. 302).<sup>8</sup> These algebraic statements can be combined as well, for example, researchers could search for all settlements that are  $> 500$  persons AND belong to a specific king. Selecting by location is a possibility as well. “Adjacency [, proximity] and containment are commonly used spatial selection operations” (Bolstad, 2005, p. 304).<sup>9</sup> For example, you could search for all communities within 500 m of a river.

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<sup>8</sup> For more on selection algebra, see *GIS Fundamentals* (Bolstad, 2005, pp. 302-4).

<sup>9</sup> For more on selecting by location, see *GIS Fundamentals* (Bolstad, 2005, pp. 304-6).



Once complete, the records which fit the chosen criteria will be selected. They can then be exported to another file and summarized. Researchers could also add a field and populate it with new data depending on the research question at hand. These selections can be based upon multiple fields and can become quite complex.<sup>10</sup> Selections can also be based upon numerical data. The process will produce tables and written analysis, and if large enough, the tables can be analyzed statistically.

## 3.5 Quantitative Techniques

A quantitative technique is an “analysis that tends to be based on the statistical summary of data” (Adler & Clark, 2003, p. 455). This section provides a discussion of the techniques used in this study. These include correlation and regression, followed by a brief description of spatial analyses and cartographic modeling.

### 3.5.1 Correlation and Regression

For analysis of the relationship between variables a number of tests are employed in this study. One such test is the Pearson correlation coefficient which “provides a standardized measure of the linear association between two variables” (Rogerson, 2010, p. 184). This test can also be displayed graphically. The line of best fit constitutes a regression analysis. Regression analysis assumes “a linear relationship exists between the *dependent* or *response* variable (*y*) and the *independent* or *explanatory* variables (*x*)” (Rogerson, 2010, p. 201). The result includes a summary table with the coefficients for the variables and their significance. This type of analysis can be conducted from a linear model to non-linear models with spatial variables as well (Anselin, 2005; O'Sullivan & Unwin, 2010).

### 3.5.2 Spatial Analysis

“*Proximity functions* or *operations* are among the most powerful and common spatial analysis tools. Many important questions hinge on proximity, the distance between

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<sup>10</sup> An historical example of querying is the *PASE Domesday GIS User Guide* (Baxter & Jessop, 2010).

features of interest” (Bolstad, 2005, p. 315). Proximity is a key variable explored in this study throughout Chapters 4 to 7. This concept was briefly mentioned in the qualitative section; however, it will be discussed in more detail here.

The main form of proximity analysis is buffering. “A *buffer* is a region that is less than or equal to a specified distance from one or more features. Buffers may be determined for point, line, or area features, and for raster or vector data” (Bolstad, 2005, p. 316). Similarly as before in the qualitative section, one could look at 500 m from a river, although in this situation an actual figure in vector or raster format would be created for display.

Another form of spatial analysis is autocorrelation. The local indicators of spatial autocorrelation (LISA) are a basic test which looks at spatial clustering in vector data. The value ranges from -1 to 1 and is significant above 0.3 or below -0.3 (O'Sullivan & Unwin, 2010, pp. 205-6). The technique is discussed by Anselin in the *GeoDa* workbook (Anselin, 2005; Anselin, Syabri, & Kho, 2006; Gregory & Ell, 2007). The analysis produces a basic Moran's *I* plot as well as a significance and cluster map (Anselin, 2005, pp. 138-42).

Interpolation is another important tool employed throughout this thesis. One method is inverse distance weighting (IDW) which is based upon the proximity of nearby known points. However, the further away a point is, the lower the influence it will have on the interpolated point. The calculation steps for this technique are presented in standard GIS textbooks (Bolstad, 2005, pp. 405-8). The distances can also be set like a buffer so the interpolated surface extends only so far from the original points. These techniques are particularly useful because researchers can set the cell size to meet the level of detail required for the study in question.<sup>11</sup>

A fourth spatial method, terrain analysis, explores the topography of a location. The main analysis tool for this section is slope, which is defined as change in elevation by

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<sup>11</sup> For an example of interpolations, see the maps in *English Seigniorial Agriculture, 1250-1450* (Campbell, 2000).

distance. The simplest formula is the change in elevation divided by the change in distance. This equation is applied to a two-dimensional slope. A raster data model (Figure 3.1) is more complex, as it comprises pixels in both a vertical and horizontal direction. Hence, a more complex formula is employed in a GIS. To evaluate this formula GIS considers elevation change both horizontally and vertically.<sup>12</sup>

Additionally, there is viewshed analysis which calculates what is visible from a certain location (Bolstad, 2005, pp. 388-90). These results can indicate what is visible from a castle or monastic bell tower. Furthermore, hydrologic statistics are commonly derived as well (Bolstad, 2005, p. 386). These are particularly useful when considering a past landscape because you can derive a drainage network based on the topography which could represent the general river path prior to any widespread human modifications (Rhodes, 2007). This knowledge could aid in identifying local land uses and the flow of resources.

Finally, standardization is a data transformation technique used to convert data from their original values to values which range from 0 to 1. This transformation technique is particularly helpful for cartographic models where there are multiple variables with different measurements. Therefore, the different variables can be easily compared. To standardize you have a choice of either a benefit or cost model. The benefit model ensures higher values are closer to 1, while a cost model sets lower values closer to 1 (Malczewski, 1999, pp. 116-9).

### 3.5.3 Cartographic Models

The final form of quantitative analysis to be examined and used extensively in this study, is cartographic modeling. “A cartographic model can be envisioned as a bound collection of maps . . . organized such that each of these layers of information pertains to a common site” (Tomlin, 1990, p. 4; Berry, 1987). This form of analysis can be conducted in both the physical and human geographic projects. The maps are manipulated with a tool

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<sup>12</sup> For more on slope, see *GIS Fundamentals* (Bolstad, 2005, pp. 379-83).

known as map algebra which is “the cell-by-cell combination of raster data layers” (Berry, 1987, pp. 320-1; Bolstad, 2005, p. 348). To ensure the layers are compatible, the processing extent and raster cell size can be set before any analysis is undertaken. The processing extent is the boundaries of the model as defined by the coordinates. Functions include simple math to complex reclassifications. An example of a simple model is presented in Figure 3.4 with the map on the far left being multiplied by 2 and then reclassified with less than 3 and greater than 7 equal to 0. The value of 1 was assigned to all values between 3 and 7 (Figure 3.4).

1	2	3	*2 =	2	4	6	Reclass: < 3 = 0 3– 7 = 1 >7 = 0	0	1	1
1	2	5		2	4	10		0	1	0
3	4	4		6	8	8		1	0	0

**Figure 3.4: Sample Raster-based GIS Analysis<sup>13</sup>**

One type of cartographic model is termed “map regression” (Rippon, 2004, p. 79). In this technique, the researcher begins with a series of maps of a location and then proceeds back in time to progressively analyze maps of a similar type. This process could involve a sequence where one begins with “Ordnance Survey maps [regressed to] . . . the Tithe Map [and then] . . . any earlier estate maps” (Rippon, 2004, p. 79). In this way, the researcher can observe “how the countryside changed over the last couple of centuries” (Rippon, 2004, p. 79). According to Rippon, the best example of this technique is by Williamson on fields in East Anglia (Rippon, 2004, p. 79; Williamson, 1987). This model does not involve heavy calculations and can be done without the aid of a computer, unlike the next two examples.

The Revised Universal Soil Loss Equation (RUSLE) is another cartographic model and is employed in this study to determine the amount of sediment which has been eroded over the Hastings and Battle areas since a specific point in time (Trenhaile, 2010; Brady &

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<sup>13</sup> This figure was developed by the author based upon figures in a GIS textbook (Bolstad, 2005, p. 348 and 355).

Weil, 2004; Renard, Yoder, Lightle, & Dabney, 2011). This value is calculated by multiplying together factors for rainfall (R), soil erodibility (K), topography (LS), land cover (C) and management (P) (Brady & Weil, 2004, pp. 526-34). This model is particularly useful where there is a limited amount of elevation change. Where there are large changes in elevation then other models should be consulted (Renard, Yoder, Lightle, & Dabney, 2011).<sup>14</sup>

The third example of a cartographic model is the multi-criteria decision analysis method (MCDA). The model is discussed in detail by Malczewski (1999, pp. viii-ix). The most common MCDA is the simple additive weighting method which is derived from a weighted average (Malczewski, 1999, p. 198). The method is calculated by first standardizing<sup>15</sup> and then assigning weights to the variables.<sup>16</sup> One method of assigning weights which takes advantage of the qualitative techniques above is to consider the frequencies of the concepts. For example, if slope was mentioned five times and woodland twice then slope should be weighted more heavily. Next, the standardized values are multiplied by the weights and summed. The area with the highest score meets all of the criteria in the model (Malczewski, 1999, p. 199). For example, in the site selection analysis of the battle in Chapter 7, the highest scores represent those areas where the battle most likely occurred. In each instance where the MCDA was calculated, multiple weights were employed and the average of the results was subsequently determined. The standard deviation was also calculated. First the square of each of the differences between the average result and the results by different weights was determined and summed together. This resultant map was then divided by the number of

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<sup>14</sup> This reference book also contains discussions of more advanced models which might be more applicable if there is a larger amount of erosion in the study area.

<sup>15</sup> There are several standardizing methods as discussed in *GIS and Multicriteria Decision Analysis* (Malczewski, 1999, p. 116). However, linear score range methods were selected as they are common (Malczewski, 1999, pp. 116-8). These methods convert the data into a benefit attribute (higher value better) or cost attribute (lower value better).

<sup>16</sup> The weights are assigned through the pairwise comparison matrix. This matrix and an analysis of the weights are presented in *GIS and Multicriteria Decision Analysis* (Malczewski, 1999, pp. 182-7).

weighted maps minus 1 and square rooted. This result indicates the standard deviation at each pixel on the map (Rogerson, 2010, p. 31).

### 3.6 Conclusion

In conclusion, this chapter has presented a detailed discussion of Historical GIS, the theory, benefits and limitations of GIS and the methods employed in the present study. It has reviewed the procedures associated with entering GIS data, and a variety of qualitative and quantitative analytical techniques using GIS.

In the concluding chapter, it will be evident that this study is firmly rooted within the field of Historical GIS. This fact will be demonstrated by presenting how this study propelled the techniques developed since the late twentieth century back further even beyond Campbell's study (2000) to a time when there were even fewer written records and no maps (Gregory & Ell, 2007, p. 179).

In pursuing this approach, a number of the methods discussed in this chapter are employed to analyze data relevant to the geographic analysis of the Battle of Hastings. Specifically, buffers, correlations, GIS-based MCDA, interpolation, LISA, map regression, querying, RUSLE, and statistical regression are used extensively to address the specific research questions laid out in the first chapter. Chapter 4 examines the historical context of the battle and research question 1 through the use of buffers, correlation statistics, interpolations, MCDA, and basic querying. Chapter 5 addresses research question 2 concerning the amount of erosion in the area since the battle through correlations, map and statistical regression, the RUSLE and a basic use of the LISA analysis. In consideration of the third research question, Chapter 6 explores the resources available to the armies at the time with interpolations and table-based analyses. Finally, Chapter 7 examines the location and development of the battle itself with buffers, MCDA and querying, thus contributing to the final questions addressing the site, development and outcome of the battle. Thus, the methodologies explained in this chapter are relied upon extensively and contribute significantly to the geographical interpretation of the battle.

To begin the investigation, the following chapter will address the geopolitical context of the battle.

## Chapter 4

### 4 England and France in the Eleventh Century

To address research question number 1, “*what can HGIS contribute to our understanding of the geopolitical state of England and northern France in the eleventh century,*” this chapter presents a unique, geographically-informed background discussion to the Battle of Hastings by examining the political state of England and northern France in the eleventh century. It reviews geographical information compiled through contemporary literary and documentary sources, using various GIS techniques (e.g. buffers, correlations, interpolations, MCDA models and querying). Specifically, the chapter examines a number of factors relevant to the battle, among them the regional geopolitics of the time, the local economy and population, and the mobilization of the respective armies of England and Normandy.

As geopolitical constructs, England and northern France of the eleventh century evolved out of the same series of Viking<sup>17</sup> raids on Western Europe in the late ninth and early tenth century (Bates, 2008, p. 19 and 91). For its part, England developed through unification. Northern France, on the other hand, experienced decentralization due to the predatory territorial actions of local lords such as the Counts of Rouen or later Dukes of Normandy (Bates, 2008, pp. 19-22; Bennett & Hollister, 2006, pp. 128-9 and 133), leading to a marked decline in the power of the French kings (Hallam, 1980). As a consequence, when English monarchs interacted with the continent, it was typically with the local count or duke, as opposed to the king. This pattern would have serious consequences for inter-regional conflicts (Abels, 2001), as will be shown in this study.

The turn of the millennium in 1000 roughly coincides with two important events that would eventually lead to the Norman Conquest of England in 1066. The first was an

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<sup>17</sup> The Vikings were pagan tribes from Scandinavia who raided and traded throughout Europe from the late eighth to the mid eleventh century. One of the great icons of this period was the long ship (Hewitt, 2010, p. 142; Hollister, Stacey, & Stacey, 2001, p. 71).



agreement between Æthelred II of England and Duke Richard I of Normandy in 991,<sup>18</sup> brokered by the Pope in an effort to end the Normans' support for the Vikings and create a unified Christian front against them (O'Brian, 2006, p. 19).<sup>19</sup> The objectives of this agreement were furthered by the second event, the marriage between Æthelred and Emma, the daughter of Duke Richard I of Normandy, in 1002. It was this marriage which allowed Æthelred and Emma's sons<sup>20</sup> to flee into exile in Normandy and upon their return, to initiate a shift in England from Scandinavian to continental affairs. In the following sections, these and related developments and their linkages to the Norman Conquest of 1066, will be further explored with reference to a geographical approach. This analysis initially focuses on England followed by a discussion of events in northern France.

## 4.1 England A.D.1000 – A.D.1066

The Kingdom of England from the late tenth to later eleventh century formed the transition state from the Anglo-Saxon period to the High Middle Ages. The pinnacle of the Anglo-Saxon period was the reign of Edgar (959 – 75).<sup>21</sup> Following the death of Edgar, there were multiple claims to the throne thus plunging England into a series of succession disputes until after 1066 (John, 1991a, p. 160). In this section, following a presentation of relevant base maps of England, the country's history will be explored from the reign of Edgar's son, Æthelred II the Unræd until 1066, with a number of distinct foci. These include a discussion of the role of government and kingship during this period, and specifically the rise of the Godwine family. Economic and demographic factors will also be explored, as well as the details associated with Harold's march to

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<sup>18</sup> The letter is reproduced in Brown (1995, pp. 164-165) or *EHD I*, pp. 823-824.

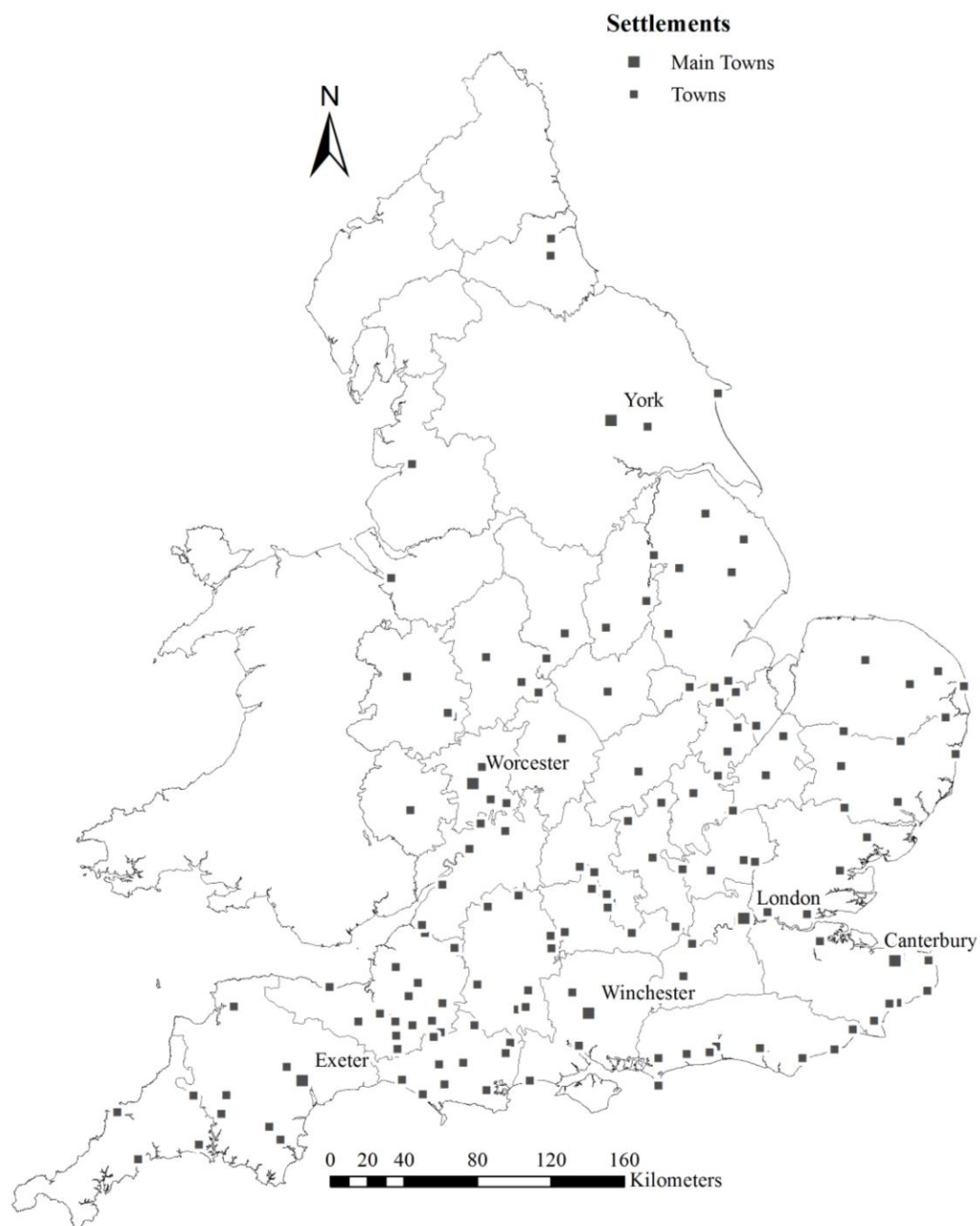
<sup>19</sup> Unfortunately, this treaty “had little long-term effect in curbing Norman involvement with the Vikings. By the turn of the millennium Scandinavian armies had once again found sanctuary in [Normandy]” (O'Brian, 2006, p. 35). This situation would not have been surprising as the Normans had been Vikings less than a century before and hence were supporting their own relatives.

<sup>20</sup> Her sons were Edward the Confessor and Alfred.

<sup>21</sup> For more discussion on Edgar's reign see: John, “The Age of Edgar” (1991a, pp. 185-9).

Hastings before the battle. This final section will include a discussion of the composition of Harold's army.

Figures 4.1 to 4.3 provide a geographical overview of the period, cartographically depicting the settlements, roads, shires and bishoprics of eleventh century England (Ordnance Survey, 1973; English Heritage, 2013; Historic Counties Trust, 2010; McCormick, et al., 2013). The figures indicate that the main settlements were in the south, with a larger concentration to the southwest (Figure 4.1). With respect to roads, these tended to be densest just to the north and northwest of London (Figure 4.2). The smallest shires were primarily north of London (Figure 4.3).



**Figure 4.1: Locations of the Settlements in England in c. 1066 with the Main Settlements Labeled<sup>22</sup>**

<sup>22</sup> The data provided in this figure were derived from a book on the period produced by the Ordnance Survey (1973).



**Figure 4.2: Estimated Extent of Roads in c. 1066<sup>23</sup>**

<sup>23</sup> The data provided in this figure were derived from a dataset maintained by English Heritage (English Heritage, 2013) and a digital atlas on the Roman and Medieval worlds (McCormick, et al., 2013).

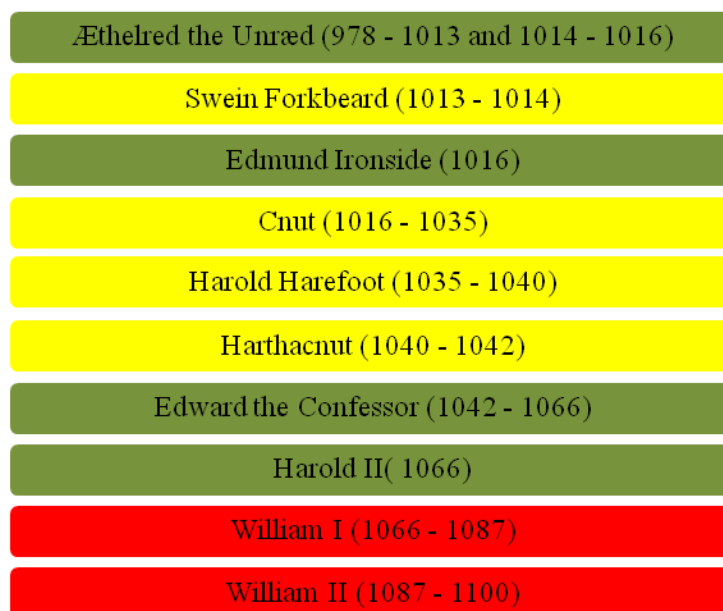


**Figure 4.3: Estimated Shire Boundaries in c. 1066<sup>24</sup>**

<sup>24</sup> The boundaries displayed in this figure come from a dataset of the historical English counties (Historic Counties Trust, 2010).

### 4.1.1 Kingship

With respect to governance, eleventh century “Anglo-Saxon England was still a fully functioning, Carolingian-style monarchy in which landholding and lordship were rooted in concepts of public power and public obligation” (Hollister, Stacey, & Stacey, 2001, p. 142).<sup>25</sup> Over the course of the century, however, England experienced a transition in kingship which had strong roots outside of the country, particularly Denmark and Normandy. Figure 4.4 depicts the transition with the English in green, Danes in yellow, and Normans in red. It is interesting to note that there were ten kings of England in the eleventh century, indicating a very high turnover rate. While the longer reigns of Cnut, Edward the Confessor and William are notable, the shorter reigns (Swein Forkbeard and Harold II) and periods of multiple kings (1013 – 1017 and 1066), demonstrated the existence of considerable political instability overall.



**Figure 4.4: A List of the Eleventh Century Kings of England**

<sup>25</sup> A Carolingian-style monarchy was centralized and possessed a similar administration to the one which existed under Charlemagne in the late eighth century (Bennett & Hollister, 2006, pp. 116-7; Hollister, Stacey, & Stacey, 2001, p. 142).

The reigning monarch in England at the dawn of the eleventh century was Æthelred II the Unræd (“unadvised”) (Higham, 1997, p. 24). His reign has widely been viewed as ineffective against the Vikings and even in maintaining his own line (line of Cerdic or Cerdicing).<sup>26</sup> Specifically, his poor leadership choices led to the collapse of the Cerdicings as a dynasty from which it only semi-recovered in the mid eleventh century (Higham, 1997, p. xviii). Æthelred’s ineptness was exemplified through several actions as discussed below.

The first signs of Æthelred’s inability to rule effectively appeared with his coronation in 978, following the murder of his half-brother Edward. Unfortunately,

no one was punished for his part in the crime, and Æthelred, who was crowned a month after the murder, began to reign in an atmosphere of suspicion which destroyed the prestige of the Crown . . . [This] was never fully restored in his lifetime . . . [Consequently, his reign lost] the instinctive loyalty of the common people, on which earlier kings had always been able to rely (Stenton, 1971, pp. 373-4).

Thus, from the beginning of the reign there was a universal mistrust of Æthelred by his people. This mistrust was further enhanced by his treatment of the nobles and his choices for key advisors.

Æthelred had in fact a challenging relationship with the nobles. In addition to an old monastic dispute<sup>27</sup> which he inherited from his father and half-brother, he “demoted, destroyed or otherwise marginalized several of the principal figures whom he had drawn into government over the previous decade” (Higham, 1997, p. 39). Æthelred’s key henchman for these endeavors was Eadric Streona, whose career post-1006 was marked

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<sup>26</sup> Cerdic was a king of Wessex from the sixth century and it is from him that all of the Anglo-Saxon kings are descended (Swanton, 1998, p. 288; Higham, 1997, p. xviii and 14).

<sup>27</sup> The monastic reforms focused on restoring “property to monastic houses throughout southern England . . . from the local noble families . . . resulting [in] animosities” (Hollister, Stacey, & Stacey, 2001, p. 90) toward the crown. For further discussion, see Hollister, Stacey & Stacey (2001, pp. 86-90) and Higham (1997) chapter 1.

by greed and disloyalty (Barlow, 2002, p. 26).<sup>28</sup> This challenge led the nobles to distrust the king's court and to transfer their allegiance to the adult sons of the king by his first wife, Ælfgifu. As a result, political division percolated within the king's household.

Even within Æthelred's family, relations were strained. While both of his marriages produced sons, clearly he favoured Emma's younger children for succession over his first wife's older sons (Higham, 1997, p. 39).<sup>29</sup> The king additionally had Eadric "remove" nobles who actively supported the older princes.<sup>30</sup>

Æthelred's ineffectiveness as a monarch was exemplified in his response to the Viking raids themselves. These raids intensified throughout his reign especially after the St. Brice's Day massacre when Swein Forkbeard, king of Denmark began to campaign in England (Higham, 1997, p. 36).<sup>31</sup> The most famous raid culminated in the Battle of Maldon in East Anglia, which the poem the *Song of the Battle of Maldon* depicts (See Section 2.1.1).<sup>32</sup> It was also after this battle that Æthelred began financial payments to the Vikings. This money, known as Danegeld, was initially paid in 994 and then at increasing rates into the early eleventh century (Hollister, Stacey, & Stacey, 2001, p. 110). This practice led to further difficulties for Æthelred and the English insofar as the kingdom now appeared to be both wealthy, on the one hand, and weak on the other (Bennett & Hollister, 2006, p. 132). In fact, "[i]n some 50 years"<sup>33</sup> the English paid £250,000 to the Vikings, suffering in addition [the imposition of] local [Viking] levies

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<sup>28</sup> "Eadric could . . . be interpreted as a loyal minister of the king . . . however . . . he . . . had few illusions concerning his own future prospects in the event of Edmund's succession . . . [so he] submitted to Cnut" (Higham, 1997, pp. 62-63).

<sup>29</sup> Barlow suggests in his biography of Edward the Confessor that at dynastic levels, there may have been clauses which stipulated about inheritance (1997, pp. 31-2).

<sup>30</sup> The oldest prince was Æthelstan who died in 1014. He was replaced by his warrior brother Edmund.

<sup>31</sup> For the St. Brice's Day massacre (1002) see Higham (1997, p. 29). According to *ASC (E)*, Swein returns to England in 1003 (p. 135).

<sup>32</sup> For a detailed analysis of the poem including the context see Scragg (1991).

<sup>33</sup> The 50 years spans roughly the period from 990 until 1040 which is into the reign of Cnut's son Harthacnut (John, 1991b, p. 198).



and much looting” (John, 1991b, p. 198). Eventually, the Vikings decided to bypass Æthelred and run the English kingdom themselves (Hollister, Stacey, & Stacey, 2001, pp. 110-1).

During the Viking campaigns of 1013 – 1014, Swein effectively became king of England from his base in the northern Danelaw. Following his death in 1014, however, the English rejected his son Cnut and sought to reinstate Æthelred to the throne.<sup>34</sup> For his own part, Æthelred had arranged through Eadric, his henchman, “the murder of . . . the two leading *thegns* of the northern Danelaw” (Stenton, 1971, p. 388) who supported Swein. Therefore, the northern Danelaw continued to distrust Æthelred and the English leadership. Nonetheless, they maintained their support for Æthelred’s son, Edmund. However, this was too late to alter the depths into which the English state had fallen in Æthelred’s reign. Ultimately, as Stenton points out, during Æthelred’s “reign . . . [h]is ineffectiveness in war . . . acts of sporadic violence, and the air of mistrust . . . with his nobles” (1971, p. 374) all compounded to produce the decline of Anglo-Saxon England. Finally, in 1016, as the *Anglo-Saxon Chronicle* relates, Æthelred “passed away<sup>35</sup> . . . after great toil and difficulties in his life” (*ASC (F)*, 1016, p. 148).<sup>36</sup>

Following Æthelred’s death his eldest son, Edmund (Ironside), was crowned king. However, Cnut decided to return in 1015 to finish his father’s conquest of England. As the *ASC* recorded in 1016:

Then, when the king learned that the raiding-army was inland, he assembled the entire English nation . . . and overtook them in Essex at the hill which is called Ashingdon, and there resolutely joined battle. Then Ealdorman Eadric did as he so often did before . . . betrayed his royal lord and . . . Cnut had the victory (*ASC (E)*, 1016, p. 151-2).

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<sup>34</sup> Swein’s son Cnut took charge of the Danes in England and left to avoid further conflict with the English. Therefore he is seen as abandoning the people of the Danelaw (Stenton, 1971, pp. 386-387).

<sup>35</sup> “He ended his days” (*ASC (DE)*, 1016, p. 148 and 149).

<sup>36</sup> Even in 1065 the authors of the *ASC* reflected on the defeats of Æthelred ((*CD*), p. 194-5).

This defeat split the kingdom in two, with Edmund as king of Wessex and Cnut as king of Mercia (*ASC (E)*, 1016, p. 153). However, with the death of Edmund in late November 1016, Cnut became king of all of England in 1017. This success has been attributed more to the death of his opponents than to his own abilities (Higham, 1997, p. 72). Still, Cnut successfully ruled England until his death in 1035, with his various military exploits discussed at length in the *ASC*.

Cnut married Æthelred's widow Emma to support the legitimacy of his rule (O'Brian, 2006, pp. 101-3). At the height of his power, Cnut held much of England, Denmark, Norway and southern Sweden (Bradbury, 1998, p. 14).<sup>37</sup> In England, he divided up the old English kingdoms into earldoms amongst his chief supporters. This decision altered the concept of kingship in England because it transferred the king's traditional power base of Wessex to one of his supporters, thus reducing the power of the English king (Barlow, 1988, pp. 54-5). Cnut also purged the English nobility which removed nobles from the previous dynasty (Barlow, 2002, p. 29).

Cnut was succeeded in England by his son, Harold who reigned from 1035–40 (Figure 4.7). However, interest in English affairs was also expressed by Æthelred's son Alfred, then living in France. In 1036, Alfred sought to return to England. The *ASC* recorded the unfortunate visit in much detail:

Alfred the blameless ætheling, son of King Æthelred, came in here, and wanted to visit his mother . . . but Earl Godwine would not allow him to . . . and set him in captivity, and drove off his companions, and some variously killed . . . No more horrible deed was done in this country since the Danes came and made peace . . . [When] it was decided that he [Alfred] be led to Ely town . . . he was blinded (*ASC (CD)*, 1036, p. 158-60).

This incident had an important impact on the events of 1066, as the Normans used it in their propaganda against the Godwine family, also contenders to the English throne. It is also important to note that this entry is from *ASC C* and *D* which were hostile or neutral

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<sup>37</sup> This empire did not survive him and it fell apart upon his death in 1035. Harthacnut became King of Denmark.

with respect to the Godwine family. By contrast, Entry *E*, which was favourable toward the family, did not record the incident.<sup>38</sup>

Following the death of King Harold, Harthacnut, Cnut's son by Emma, succeeded to the throne (1040 – 1042). It has been surmised that in 1040, Harthacnut and Magnus I of Norway had agreed that they would recognize “the other as heir if either should die childless” (Higham, 1997, p. 188). Therefore, it was this agreement which “legitimized the ambitions” (Higham, 1997, p. 188) of Magnus toward the English kingdom.

Nonetheless, he did not try to claim the throne in 1042 on the death of Harthacnut, and in fact died in 1047 and was succeeded by Harald Hardrada (Higham, 1997, p. 117 and 188). Importantly, it was through this arrangement that Harald claimed the English throne in 1066.<sup>39</sup>

Upon the death of Harthacnut, the crown passed to Edward the Confessor. Edward represented a return to the Cerdicing line. However, from 1013 until his return in 1041, he had been living in northern France (Hollister, Stacey, & Stacey, 2001, p. 112). Therefore, England's “geography, traditions, governmental structures, perhaps even its language, would have been unfamiliar to him” (Huscroft, 2009, p. 86). He also brought northern French courtiers and French attitudes to the English throne. Cnut's decision to convert the old kingdoms into earldoms was also a challenge for Edward because unlike previous English kings, this monarch did not have the loyalty of his chief lords and in particular Godwine, Earl of Wessex (Barlow, 1988, pp. 54-5). Additionally, it is suspected that Edward harboured a distrust of Godwine due to his role in Alfred's death in 1036 (Huscroft, 2009, p. 84). It was this distrust which helped fuel the crisis of 1051-52. During this period, the Godwine family had opposed Edward, either over an ecclesiastic appointment or the visit of a foreign leader. Either way, they were summarily

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<sup>38</sup> Interestingly, the *VER* records the incident (p. 20) and as presented in Chapter 2, the author of this document would have been sympathetic to the Godwines.

<sup>39</sup> The invasion of England in 1066 by Harald Hardrada and Tostig is dealt with in detail by DeVries (2003) and will be discussed where applicable.

expelled from the country (Barlow, 2002, pp. 56-8).<sup>40</sup> The exile of the Godwines, one of the most powerful families in England, is important in relation to the Norman Conquest as it is suspected that during the Godwines' exile Edward offered the crown to Duke William.<sup>41</sup> It was also during this time that hostages were transferred between Edward and Godwine. These hostages included Godwine's son Wulfnoth and grandson Hakon who were sent to William in Normandy for safekeeping (Barlow, 2002, p. 72). As an excellent example of the use of geography to understand history, one historian has examined the movements of the Godwine family, including Harold, in the *ASC* using basic spatial analysis and other techniques presented and expanded upon in this project (Chapter 3). This mapping indicates that the Godwine family returned to England through Kent and East Sussex (Lavelle, 2010, pp. 202-7).<sup>42</sup> According to the *VER*:

The sea was covered with ships. The sky glittered with the press of weapons. And so at length, with the soldiers made more resolute by mutual exhortation, they crossed the Kentish sea . . . [and] entered the mouth of the River Thames (pp. 26-7).

Upon disembarking at Southwark, Godwine met the king the following day (*ASC (CD)*, 1052, pp. 180 and 182). In the meeting Godwine "threw himself at his feet, and begged . . . permission to purge himself of the crime . . . The king . . . constrained both by his mercy and the satisfaction offered by the earl – who . . . appeared much superior in arms" (*VER*, p. 27-8) accepted the peace offering.

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<sup>40</sup> The ecclesiastic appointment was of a Norman, Robert of Jumièges to Canterbury while the visit of the foreign leader was Eustace of Boulogne, King Edward's brother-in-law (Barlow, 2002, pp. 56-8).

<sup>41</sup> There is some debate about the authenticity of this claim as William was related to Edward on his mother's side and Edward and male relatives on his father's side. There is also the point that William was not involved with English politics until the 1060's (Huscroft, 2009, pp. 94-5). However, it is reported in the *ASC* that he did visit England in 1051 (*(D)*, 1051, p. 176).

<sup>42</sup> In his analysis, Lavelle included a table with the documents presented and locations bolded. A map was also included which presented all of the places mentioned in the document. However, Lavelle focuses on the political event whereas in this study the important element is the mapping of the document (2010, pp. 202-7).

Following the family's return in 1052, Godwine died at Easter in 1053 apparently after assuring King Edward of his loyalty to the crown. Following his death, he was succeeded as Earl of Wessex by his son Harold.

King Edward began negotiations for the return of his half-nephew Edward the Ætheling to England.<sup>43</sup> However, Edward the Ætheling died in 1057 before he had the chance to meet the king. Therefore, the new heir to the Cerdic household was Edward the Ætheling's son, Edgar, who was five at the time (Barlow, 2002, p. 82). Thus, when King Edward died in early January 1066, Edgar, by then in his early teens, was considered still too young to rule (Barlow, 2002, pp. 82-3). Consequently, in accordance with the wishes of the dying King Edward (*ASC (CDE)*, 1065, p. 194-5 and 197), Harold II Godwineson, was named King of England just prior to the Norman Conquest (Huscroft, 2009, pp. 108-9). Harold II plays a key role in the development of the Battle of Hastings. The rise of Harold II will be examined in Section 4.1.2.

#### 4.1.2 Harold II Godwineson

Godwine had nine known children. The most famous were Edith (wife of King Edward), Harold, and their brothers Tostig, Gyrth and Leofwine. Another brother, Wulfnoth, was held hostage in Normandy (Barlow, 2002, p. 72). In the period leading up to the events of 1066, three significant events befell Harold Godwineson. The first significant event was Harold's visit to Normandy in 1064 (Barlow, 2002, p. 94). Although the origins and reasons behind this visit are obscure (some reference has been made to the fact that Harold may have been taken hostage by another French lord and handed over to William) (*BT*, Plates 8 – 16; *WP*, pp. 69-71), what is certain is that Harold observed Norman tactics during a campaign into Brittany and William obtained an oath from Harold to support his claim to the throne (*BT*, Plates 20-9; *WP*, pp. 71-7).<sup>44</sup> William in turn employed this oath to help obtain support for the Norman Conquest in 1066.

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<sup>43</sup> Edward the Ætheling's father was Edmund Ironside, King Edward's half-brother.

<sup>44</sup> The *BT* has the military campaign first followed by the oath while *WP* has the oath first then the campaign (*BT*, Plates 20-9; *WP*, pp. 71-7). This campaign would have given Harold a sense of William's abilities as a general.

The second event(s) were Harold's raids into Wales. One raid occurred in early 1063 which sought to subjugate a Welsh king (Walker, 1997, pp. 88-9). Another invasion took place in 1065. This action was intended to protect merchants and trade in the area. Harold even constructed a base at Portskewitt in southern Wales for trade and hunting. However, after Harold departed, the Welsh attacked and successfully destroyed the site in late August 1065 before it was in use (Barlow, 2002, pp. 115-6). Therefore, despite the loss of the base at Portskewitt, these military adventures solidified Harold's credentials as a successful military leader fit to rule (Walker, 1997, p. 90).

The third significant event, the rebellion in Northumbria, occurred during the fall of 1065. Local rebels rose up against Tostig and asked for Morcar, the brother of the Earl of Merica to rule their territory. This political division provided a problem for Harold who supported the rebels and exiled Tostig. With Tostig in exile, Harold gained allies in the North but he caused a division within his own family. This price, however, may have been worthwhile, as some have suggested that Harold might have sought allies across England after he realized William was interested in the throne (Huscroft, 2009, p. 107). Tostig, on the other hand, left England for Flanders, the homeland of his wife (*ASC*, (*CD*), 1065, pp. 192-3). Eventually, Tostig joined forces with Harald Hardrada of Norway when he invaded England in early September 1066. Therefore, at this time, Harold had a powerful enemy to face in the north.<sup>45</sup>

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<sup>45</sup> For more information on the relationship between Harold and Tostig see DeVries' book on the Norwegian invasion in 1066 (2003, pp. 168-92).



**Figure 4.5: Godwine Family Lordships and Estates in c. 1066<sup>46</sup>**

<sup>46</sup> This figure is derived from a database maintained by King's College London (2010).

Figure 4.5 indicates the extent of the Godwine family's lordships and estates in 1066. As demonstrated on the map, the family's holdings were distributed across the country. However, many of the main sites tended to be west of London and situated along the Sussex coast. There were also a number of estates in the northern midlands and in East Anglia. While these data indicate that the Godwine family had extensive power across much of the country, such control was not unheard of, particularly since the late ninth century (Hallam E. M., 1980, pp. 20-1). In France, the Capetian dukes, for example, replaced the Carolingians as kings of France by taking power when "the heir [to the previous dynasty] was clearly too young or too weak to carry out his kingly duties [with] the throne pass[ing] into the hands of nobles with power, wealth and influence to rule" (Hallam E. M., 1980, pp. 20-1). In the case of the Godwinesons, Harold became king over Edgar the Ætheling because he was too young to govern. Harold would have likely known about the Capetian example and intended to follow suit (Huscroft, 2009, pp. 104-5). Thus, Harold was acting more than just in the interests of his kingdom; he was acting as any English or Frankish lord in the period (Barlow, 2002, p. 175).<sup>47</sup>

### 4.1.3 Economy and Population

In further pursuit of question 1, it is important to consider the economy and population of England and Normandy as key factors in understanding the broader context of the period and its influence on the Norman Conquest. This also provides background to the discussion in Chapter 6 on the importance of resources in sustaining the two armies.

The following section presents a spatial depiction of England's wealth at the time. Before the Norman Conquest, England was "a hierarchical society, dominated by a landowning aristocracy of nobles and thegns" (Hollister, Stacey, & Stacey, 2001, p. 141). Figure 4.6 presents the development of the economic centres in pre-Conquest Anglo-Saxon England. The map was developed by recording all of the locations which contained a town, mint, bishopric or abbey from before the Norman Conquest. A "1"

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<sup>47</sup> The key problem with Harold's bid for power was there were multiple contenders for the throne. Conversely in the Capetian example, there was no desired alternative (Hallam E. M., 1980, pp. 23-4).



was then assigned to each location for its feature. The exception was the town feature, categorized from 1 to 3 with 1 being the top category and 3 the lowest. This categorization was incorporated into the representation by assigning a value of 3 to the first category followed by 2 and 1 for categories 2 and 3 respectively. This numbering ensured that the most important centres would have the highest values. For locations which held multiple features, such as an abbey and bishopric, the values were then added together. The practical results of this analysis are presented below in Table 4.1. A cartographic display of this evidence, graphically depicting the main settlements of importance in England at the time that could have helped sustain the English army in 1066 at Hastings is presented in Figure 4.6 (Ordnance Survey, 1973). For example, Canterbury, London and Winchester all would likely have had grain stores which the English forces in the Hastings area could have accessed had they required them.

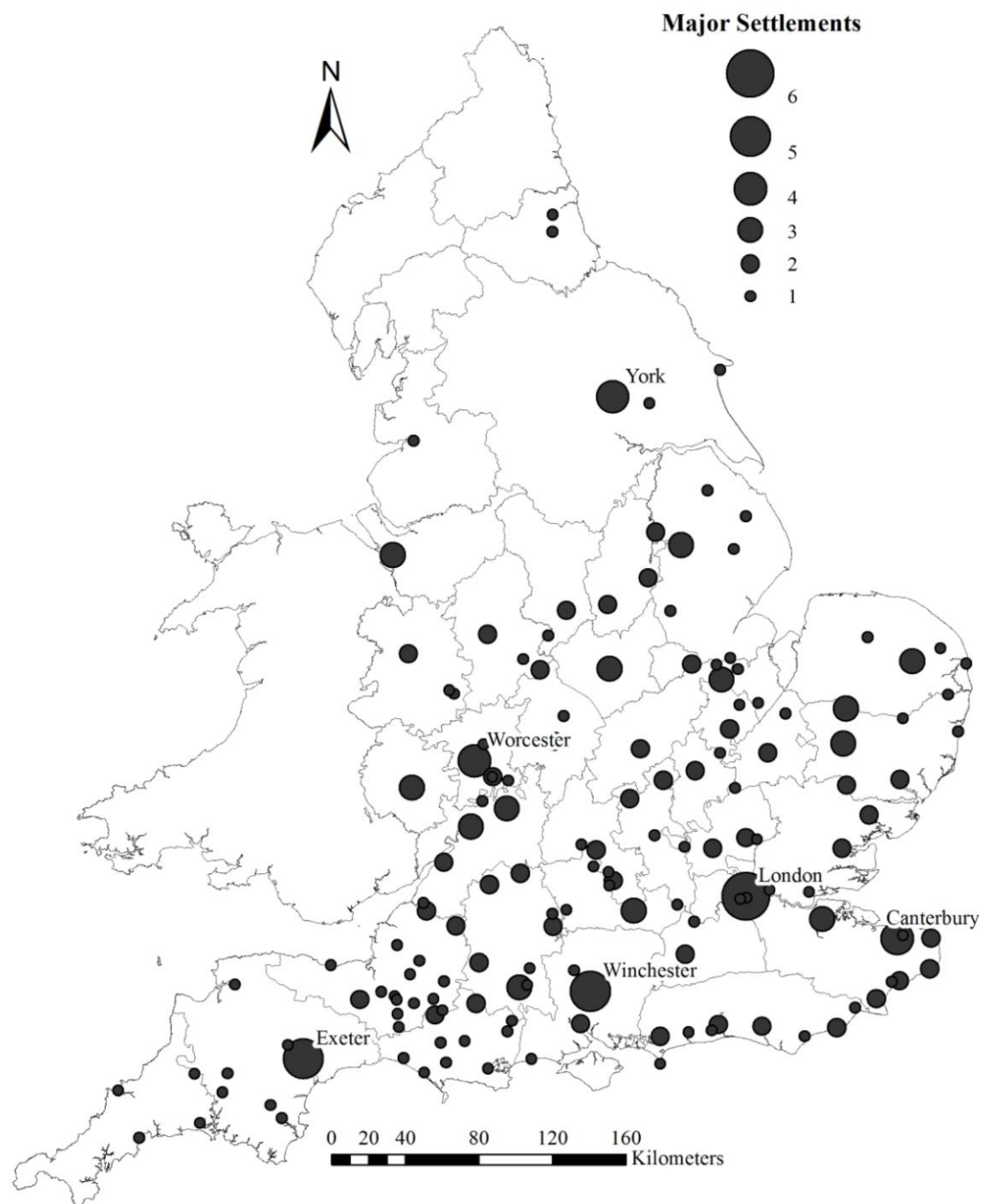
**Table 4.1: Sample Database of English Settlements<sup>48</sup>**

<b>Name</b>	<b>Town</b>	<b>Mint</b>	<b>Abbey</b>	<b>Bishopric</b>	<b>Value</b>
London	3	1	1	1	6
Exeter	2	1	1	1	5
Winchester	2	1	1	1	5
York	2	1		1	4
Canterbury	1	1	1	1	4
Worcester	1	1	1	1	4
Chester	2	1			3
Lincoln	2	1			3

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<sup>48</sup> The data presented in this table comes from a book on the period produced by the Ordnance Survey (1973).

Figure 4.6 indicates that there were several large and prominent communities in England at this time, including London, Winchester, York as well as Canterbury, Exeter and Worcester. The smaller centres are fairly evenly distributed across the country although less present in northern England and in the Weald area of the southeast. Therefore, there is an evident spatial pattern on the economic standing of communities in late Anglo-Saxon England (Ordnance Survey, 1973).



**Figure 4.6: Development of Major Settlements in Late Anglo-Saxon England (c. 1066). Names Apply to Largest Symbol in Vicinity<sup>49</sup>**

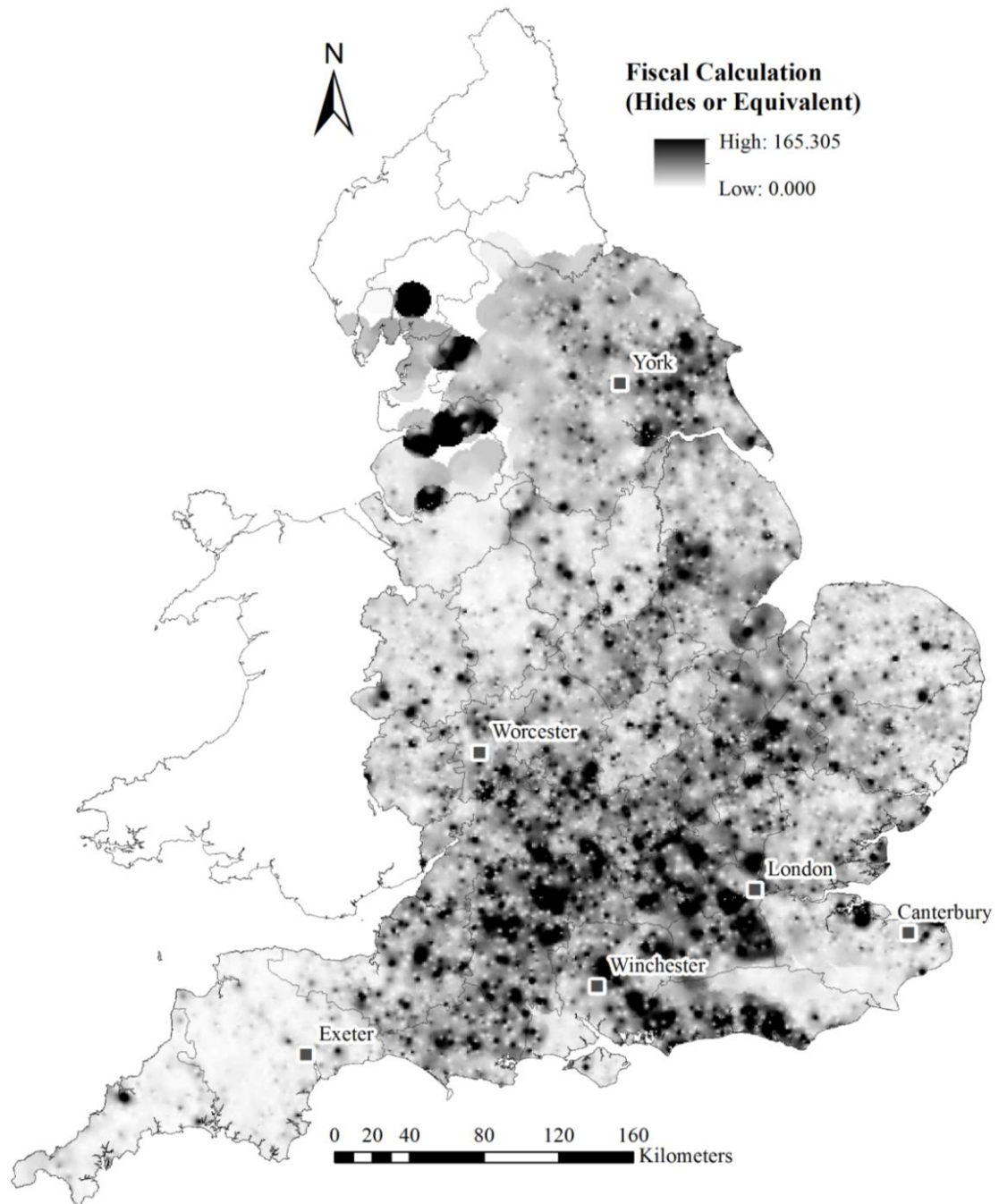
<sup>49</sup> The data provided in this figure comes from a book on the period produced by the Ordnance Survey (1973).

Figure 4.7 presents an interpolation of the fiscal calculation value for all of the *Domesday* villages which would have been important in understanding the regional and local capacity for military service.<sup>50</sup> The interpolation method selected was the inverse distance weighting method.<sup>51</sup> The fiscal calculation is a value “which expresses the fiscal assessment of each landholding as a single number of hides or equivalents of hides” (Baxter & Jessop, 2010, p. 109). The interpolation has a radius of ten kilometers around each settlement. The distance of ten kilometers was selected as “the median distance between the town and the villages where buyers and sellers lived varied between eight km and 12.5 km” (Dyer, 1996, p. 23). Furthermore, by interpolating from a *DB* dataset, and not aggregating to boundaries like the Darby maps (1977), this map reduces the errors associated with the MAUP and the ecological fallacy. Thus, Figure 4.7 presents a distribution of hides which is more reflective of the original data.

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<sup>50</sup> The villages were preferred because for some locations there were multiple records so an aggregated value would be more reflective of the location.

<sup>51</sup> This interpolation went beyond the coast and into the sea. To ensure that just data from the land was presented, the interpolation was multiplied by a single value (1) raster of England. Therefore, the data beyond the coast were excluded from the presentation.



**Figure 4.7: Fiscal Calculation from the *Domesday Book* for c. 1066 at a Resolution of 1 km<sup>52</sup>**

<sup>52</sup> The data provided in this figure were derived from a database by King's College London (2010).

From this interpolation, it can be seen that the highest values are to the west of London and along the south coast. There are also some higher values in the north near York. This trend indicates that the wealth of the country in terms of land is in the mid-south-west. Again there is an absence of evidence in the Weald area. This regional concentration of landed wealth would have provided a significant source of resources for the English army at Hastings and is further discussed in Section 4.1.5.

#### 4.1.4 Events in 1066 before William's Arrival

There were several important events which happened during 1066 before the Battle of Hastings, signaling that the battle was not an isolated occurrence and must be placed in the context of the events transpiring throughout the year.

The first major event was a campaign led by Tostig against his brother, King Harold of England, in May 1066 which saw fighting along the English coastline from the Isle of Wight to Sandwich and the north (Barlow, 2002, pp. 134-5). In response, Harold and one of his brothers gathered together a force to respond to the invaders (Barlow, 2002, p. 135). This force was ultimately stationed on the Isle of Wight which had the added benefit of providing defense against William in the event that he set sail from Normandy. However, the length of required military service for many of the recruits expired (Chapter 2) and the force disbanded (Barlow, 2002, p. 135), leaving the south coast undefended. Meanwhile, Tostig joined forces with King Harald of Norway who had invaded in the north of England in an effort to claim the throne.<sup>53</sup> The campaign itself is summarized in detail in the *C* version of the *ASC*<sup>54</sup> which states:

King Harald from Norway then came by surprise north into the Tyne with a very great raiding ship-army . . . and Tostig came to him with all that he had got . . . and then both went with all the fleet along the Ouse up towards York. Then King Harold, in the south, was informed . . . [and] went northward , by day and night . . . [but] before . . . king Harold could

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<sup>53</sup> Tostig did some preliminary raiding on Lindsey but was defeated “by Earls Edwin and Morcar and suffer[ed] the desertion of most of his sailors” (*ASC (D)*, 1066, p. 197) (Barlow, 2002, p. 136).

<sup>54</sup> The campaign is discussed in *ASC D* and *E* as well but in less detail.

come there, Earl Edwin and Earl Morcar had . . . fought with that raiding-army and made a great slaughter . . . and the Norwegians had possession of the place of slaughter (1066, p. 196).

The above engagement is referred to as the Battle of Fulford which occurred on Wednesday, September 20, 1066. Following the battle, King Harald and Tostig proceeded to York and made arrangements for hostages and supplies. It is reported that they proposed to lead the Northern English in an effort to conquer the remainder of the country and establish a state with the capital in York ((C), 1066, p. 197). However, this arrangement would not come to pass as King Harold, marching north with his army, reached York by Monday, September 25, 1066 as indicated in *JW* (p. 603). Harold proceeded to Stamford Bridge where he met King Harald and Tostig awaiting the hostages. Here,

they joined battle and were fighting very hard long in the day; and there Harald, king of Norway was killed and Earl Tostig and countless people with them . . . [and then] the English, came over the bridge . . . and there made a great slaughter of both Norwegians and Flemings; and Harold let the king's son . . . go home to Norway with all the ships (C), 1066, p. 198).

Thus, this event brought to an end the Norwegian quest for the throne of England (DeVries, 2003, p. 296).<sup>55</sup> It also solidified Harold's credentials as a capable leader. However, Harold had little reprieve as William arrived in England on either September 28 or 29, 1066 (*ASC*, (*DE*), 1066, pp. 198-9).

#### 4.1.5 March to Hastings

News of William's invasion would likely have reached Harold in York and the remainder of the kingdom through a variety of methods, each of which can be subject to geographic analysis. One method was by horse or foot. In one reference, several values were provided which estimate the distance an army could travel in one day (Lavelle, 2010, p. 192). These values are mapped for a seven day period in Figure 4.8 and cover the vast majority of England. However, Figure 4.8 assumes that information flowed out in a

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<sup>55</sup> For a detailed reconstruction of the Battle of Stamford Bridge, see DeVries (2003, pp. 262- 96).

straight line at a uniform rate from the Hastings area. In reality, information would have been distributed from this area organically and at varying speeds. Therefore, the map represents the possible locations which could have known about the Norman landings within seven days of the event. Seven was selected because there were 14 days between the Norman landings on September 29 and the day before the battle on October 13. Assuming the same amount of time to go out and come back by horse then the buffer distance became seven days or 336 km.<sup>56</sup>

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<sup>56</sup> 336 km comes from multiplying the daily travel rate of 48 km by seven days.





**Figure 4.8: Estimated Travel Distance in Days from East Sussex (c. 1066)<sup>57</sup>**

<sup>57</sup> The data behind this figure were based upon measurements presented in Lavelle's book on the Anglo-Saxon military (2010, p. 192).

Fire beacons represent yet another method of information dispersal. Historical documents and maps suggest that there were fire beacons in the Sussex area at the time of the Spanish Armada (Woodburn, 1999, p. 102).<sup>58</sup> Further documentary evidence from prior to and during the eleventh century including the *ASC* as presented in an article on Anglo-Saxon beacons in Hampshire, suggests that beacons existed in this period (Hill & Sharp, 2010, pp. 218-22). The authors also link sixteenth century beacon sites with known Anglo-Saxon sites (Hill & Sharp, 2010, p. 222). Thus, they suggest that beacons in existence in 1588 were probably present during the Norman Conquest (Woodburn, 1999, p. 102; Hill & Sharp, 2010, pp. 222-3).<sup>59</sup> Were this method in fact employed, knowledge of the Normans' arrival would have spread over the area much faster than simply by riders.

Just as spatial analysis can contribute to a better understanding of information flows in the initial days of the Norman Conquest, so too can it provide real clues as to the eventual composition of Harold's army at the time of its arrival at Hastings. One GIS-based technique is cartographic modeling which can determine the geographic origin of the soldiers who potentially served in Harold's army. To construct this model, several variables were required. The existing literature describes a relationship between the calculation of wealth (hides) and military service (Figure 4.7). An additional variable relates to Harold's family, the Godwines. Specifically, if it is assumed that the battle was a direct attack on the Godwines, as is indicated by *WP* and the *BT* among others, then individuals who were vassals of Harold and his family (Gyrth, Leofwine, and Godwine, his father) would be more likely to fight for Harold and to maintain his line (Figure 4.5). This, in fact, could represent one of the most important variables in the model. Another

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<sup>58</sup> One of the Armada maps discussed in Appendix I indicates the locations of beacons (Lower, 1870; *BL*, Add MS 57494 f. 13).

<sup>59</sup> This reference was originally published as Hill, D. & Sharp, S. (1997). An Anglo-Saxon Beacon System. In A. R. Rumble & A. D. Mills (Eds.), *Names, Places and People: An Onomastic Miscellany in Memory of John McNeal Dodgson* (pp. 157-165). Stamford: Shaun Tyas. However in this study, the reference will be from a reprint: Hill, D., & Sharp, S. (2010). An Anglo-Saxon Beacon System. In R. Lavelle, *Alfred's Wars: Sources and Interpretations of Anglo-Saxon Warfare in the Viking Age* (pp. 218-225). Woodbridge, UK: The Boydell Press.

important factor is the site of the battle itself, and the relative proximity of available combatants. Figure 4.2 displays potential travel routes to the battle site.<sup>60</sup> However, individuals probably travelled the best route they knew which may or may not have included the local roads.

Figures 4.9 and 4.10 graphically demonstrate where Harold likely drew his soldiers from for the battle. The data used in these figures were analyzed using map algebra, as follows. The proximity to the Godwine family estates, roads and the battle location were determined by the Euclidean distance raster function. This function created maps where higher values represented further distance from the selected features.<sup>61</sup> Next, in order to compare the different values, the maps were standardized with the fiscal calculation as a benefit attribute (higher value better) and the proximity to the estates, roads and battle location as cost attributes (lower value better). The values were standardized because the different maps represent different measurements which cannot be compared. Therefore, all the maps were transformed to a standard range of 0 to 1 (Malczewski, 1999, pp. 116-8).

At this point, the different maps can be combined into one map to predict military service in the English army at Hastings. This calculation will be evaluated with the simple additive weighting method (SAW) (Malczewski, 1999, pp. 182-7). However, the maps require weights as each variable has a different level of importance. Since we do not know the level of importance assigned to each factor, an equal weight was assigned to all of the maps. The equal weights map (Figure 5.9) indicates the most likely areas to participate were in the southeast and the least likely were in the north and west. However, the map also indicates an individual's proximity to the road network does appear to figure prominently in the model. Therefore, to ensure the reliability of the results, the value was recalculated with one variable weighted at 40 percent and the others at 20 percent. The standard deviation was then calculated for each cell between

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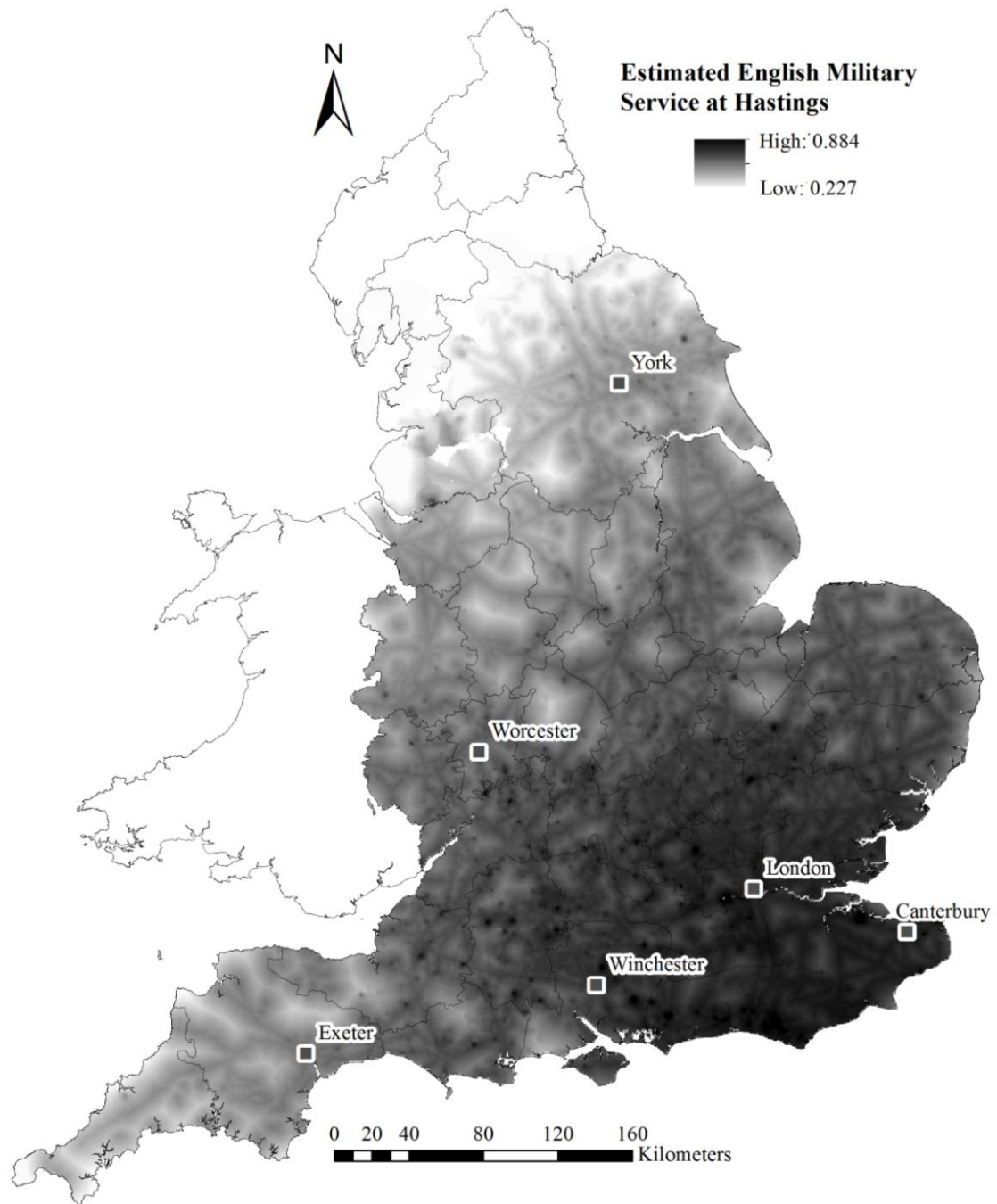
<sup>60</sup> “[R]oads were important in the movement of Anglo-Norman armies” (Morillo, 1994, p. 116).

<sup>61</sup> See note above about data beyond coast of England.

the five maps. Figure 4.10 displays the standard deviation of the equal weights map. The colour scheme was reversed for this map with lower values as darker as a lower standard deviation suggests a model with a better fit in relation to the data. The range of values suggests that the standard deviation is small which implies that the various factors did not have a strong influence on the model's results. Again, the road network does appear to be prominent in the map, which suggests the importance of roads on the mobilization of armies. Interestingly though, the area around East Sussex appears to have a higher standard deviation than what would be expected given the proximity to the battle site. This finding indicates that there were clear variations in the results but overall the model is robust. Therefore, it is reasonable to assume that Harold would have likely drawn his army from the areas around East Sussex for the battle as Figure 4.9 demonstrates. This exercise has indicated the importance of geography in understanding exactly how Harold might have assembled his army for the Battle of Hastings.<sup>62</sup> However, what it does not indicate is how many soldiers fought for Harold. For that estimation, another GIS-based technique will have to be considered.

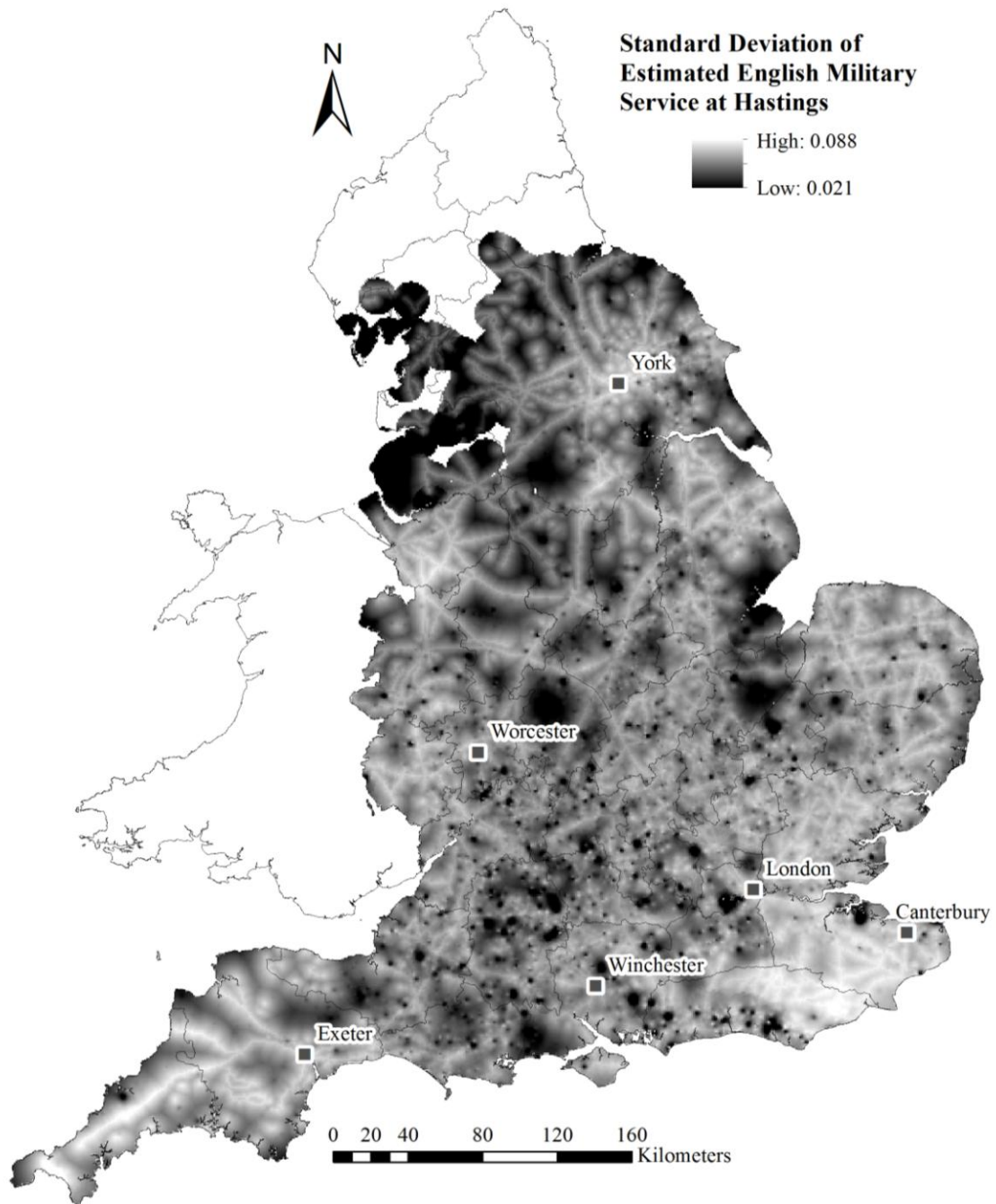
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<sup>62</sup> Historians will never be certain as to how Harold assembled his army but by considering factors which are likely to have influenced it, researchers can get a glimpse into how he might have.



**Figure 4.9: Estimated Likelihood of Military Service at Hastings at a Resolution of 1 km (c. 1066)<sup>63</sup>**

<sup>63</sup> This figure was compiled from two sources (English Heritage, 2013; King's College, London, 2010).



**Figure 4.10: Standard Deviation of Estimated Likelihood of Military Service at Hastings at a Resolution of 1 km (c. 1066)<sup>64</sup>**

<sup>64</sup> This figure was compiled from two sources (English Heritage, 2013; King's College, London, 2010).

Figures 4.9 and 4.10 demonstrate global results relating to the likelihood of military service for all of England. In order to estimate the likely number of soldiers in the English army specifically, another GIS technique must be applied. If the points where the fiscal calculation is above 5 are extracted from the database, then following the five hide rule for professional soldiers (explained in Chapter 2), the estimated army size is 10000. Thus, considering the battles prior to Hastings and the potential delay in the spread of information, this value is close to the estimated value reported in Section 2.6.3.1, of approximately 8000 men. However, in some areas there were fewer men reported than were probably available, such as in Nottinghamshire. Additionally, some areas might be reporting more men than were probably available. Therefore, the value can only provide an approximate estimate of the military potential for the entire country in October 1066.

In order to narrow down further who fought at Hastings, another useful technique is GIS-based querying. Based upon the *Domesday* database, only 30 holdings were held as either a lordship or as a subtenant in both 1066 and 1086. This statistic indicates that as indicated in the literature, there was mass change in property during the Norman Conquest. Hence, it would be challenging to deduce who fought at Hastings by merely looking at which property owners were no longer present after 1086. Therefore, based upon the evidence available, a list of places which could have contributed militia to the battle would have to be developed. This list was developed by only examining villages with five hides or more, which were within ten kilometers of a Godwine estate or Roman road<sup>65</sup>, and were three days ride or six days march from Battle.<sup>66</sup> In terms of the five hide system, the estimated total was around 2500, although it could be suggested that the English professional soldiers, as in the case of the Norman cavalry, would have brought additional levies (*ge.neat*) from their estates (*A-S*, p. 247; *EHD* II, p. 875) (Hewitt, 2010,

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<sup>65</sup> 10 km was selected because it is roughly how far a person on foot would travel in a day before turning around and returning home for the night.

<sup>66</sup> This distance was selected because the foot soldiers would have to march on foot to the battle which is not as speedy as on horseback. Furthermore, it takes time for people to organize a proper defense against an invader.

p. 133). Assuming each professional soldier brought two men each, the army size could be 7500 men. This value is again similar to the army size as estimated by historians, thus demonstrating the importance and utility of applying a geographical analysis to historical observations.

#### 4.1.6 Summary

In summary, viewed with the assistance of a geographical perspective, the changes in English kingship from 1000 until 1066 provide an important indication of the state of the country and Harold's rule leading up to the Norman Conquest. From the discussion above, it is apparent that the elite of England in 1066 would have had few ties to the state from before Æthelred II. Therefore, the English leadership of 1066 were not the great defenders of the Anglo-Saxon state but the heirs to the transition state which had evolved since 1016 (Huscroft, 2009, p. 86). Thus, it was this leadership which suffered the replacement of the old Wessex-based Anglo-Saxon kingdom with one by northern Frenchmen.<sup>67</sup>

In addition, analysis of demographic and economic factors revealed trends of importance to understanding the Battle of Hastings. The fact is that England in 1066 had multiple large centres with London as the largest. The interpolation of the fiscal calculation also revealed with some precision the relative distribution of wealth throughout the country. Again, this evidence would have serious implications as regards to the organizing, mobilizing and supplying of armies.

The final section explored the mobilization of Harold's army for the Battle. Evidence was assembled with cartographic modeling based upon four factors. There was an indication that the majority of the army came from south-east England and participation was related to the road network. Furthermore, a simple query based upon relevant criteria produced a reasonable estimate for the size of Harold's army. Thus, this

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<sup>67</sup> Initially the kings were Normans (William I, II and Henry I) but from 1154 onwards they were Angevins or Plantagenets (Henry II, Richard I, and John etc.).



assessment demonstrates the importance of geographic analysis to understanding military service in late-Anglo-Saxon England.

## 4.2 Northern France A.D.1000 – A.D.1066

In this section, the same analysis as presented in section 4.1 will be again undertaken but will be applied to northern France. Northern France at this time was a series of duchies and counties supposedly loyal to the Frankish<sup>68</sup> or French king. From his base in Paris or the Île-de-France, the king, “known as the *Rex Francorum*<sup>69</sup> – king of the Franks” (Hallam, 1980, p. 6) was in theory the reigning monarch, but in reality “one prince among many” (Bennett & Hollister, 2006, p. 133; Hallam, 1980, p. 64). It is within this context that William’s base of power must be understood.

The most prominent of the northern French lordships were Anjou, Brittany, Flanders, Maine, Normandy and Ponthieu. However, unlike in England where the historic counties remained in use well into the twentieth century, in France constant border changes occurred until the mid-fifteenth century. This was further complicated by a political revolution in the eighteenth century. Thus, the original borders of Normandy at the time of the Norman Conquest can only be estimated. Insofar as these borders are important for understanding the geopolitical context of the time, an attempt is made to do just that in this section.

As many of the geographic datasets that exist for medieval England, such as county borders, do not exist for France, a number of datasets have been developed by the author specifically for this project as discussed below. This map, which appears as Figure 4.11, is based on a single geo-referenced and digitized source map depicting Normandy from the time before the French Revolution (1789), the Delisle map. The Delisle map is a

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<sup>68</sup> The people who inhabited what is modern France were known in this period as Franks from a tribe which succeeded the Roman Empire in the West. For a brief discussion of the Franks, see elements of chapters 2, 3 and 5 in *Medieval Europe: A Short History* (Bennett & Hollister, 2006). For a more in depth analysis of this period in France, see *Capetian France, 987-1328* (Hallam, 1980).

<sup>69</sup> JW also uses the term in reference to the death of Henry I of France in 1060 (JW, p. 586-587).

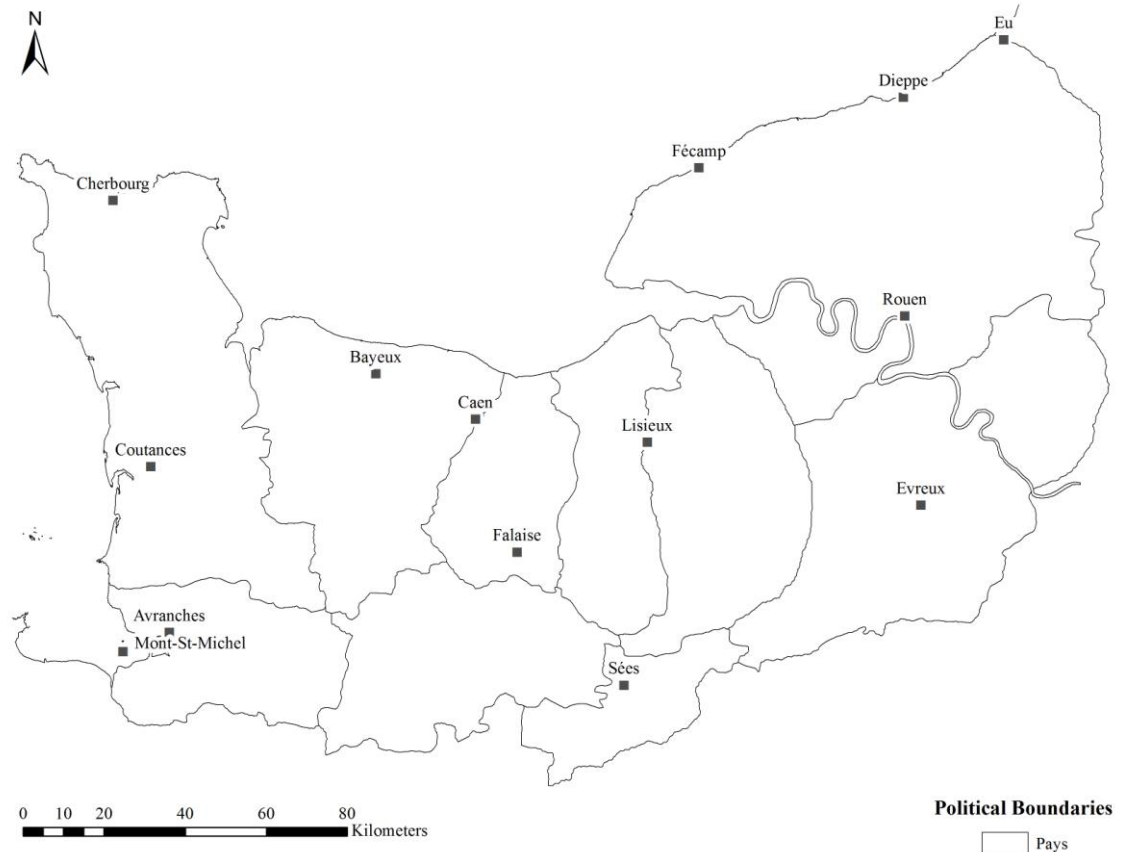
detailed cartographic depiction of Normandy in the early eighteenth century with borders, towns and roads presented.<sup>70</sup> The map is considered applicable to the eleventh century because: 1) change was typically slow, especially before the twentieth century (Hoskins, 1977), 2) it is detailed in terms of the number of settlements displayed, and 3) the cartographer who developed it worked from numerous sources (Petto, 2007, p. 181; Rumsey & Williams, 2002, p. 1). At the geopolitical level, the digitization process as it was undertaken here, focused on tracing the predominant political boundaries of the region from the Delisle map. The main settlements were plotted as well. This figure thus provides a reliable geographical context for the duchy.

Following the mapping exercise, this section of the chapter, in further addressing research question 1, will provide an historical overview of the Norman nobility and their interactions with the Kings of France, within the context of local demographics and economics. The section will conclude with an examination of the mobilization and composition of William's army.<sup>71</sup>

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<sup>70</sup> See Appendix A for an historical interpretation of the map.

<sup>71</sup> This section will be based in part on the findings of an earlier article published by the author (Hewitt, 2010).



**Figure 4.11: Estimated *Pays* of Normandy from c. 1066<sup>72</sup>**

#### 4.2.1 Ducal and Frankish Power

Like England, the dawn of the millennium brought new changes to the Frankish kingdom. For one, the year 1000 roughly corresponds with the beginning of a new dynasty, the Capetians<sup>73</sup> in 987, coinciding with the succession of Hugh Capet as King of the Franks (Hallam, 1980, p. 20).<sup>74</sup> The political origin of this change in royal houses is examined by Hallam, who at the same time emphasized the fact that royal authority was

<sup>72</sup> The borders provided in this figure are derived from the 1716 Map of Normandy as discussed in Appendix A (Cartography Associates, 2012; Delisle, 1716).

<sup>73</sup> The previous house was the Carolingian line which came from the time of Charlemagne.

<sup>74</sup> The Capetians became kings of France because they were the power behind the throne and when the throne became vacant upon the death of Louis V, Hugh succeeded to the throne (Hallam, 1980, pp. 20-1).

essentially disseminated to the local lords (1980, pp. 20-4). Thus, although there were comparatively few French monarchs during the eleventh century<sup>75</sup> (compared to England) (4.1.1), the benefits of a low political turnover rate were essentially nil, insofar as they were effectively mitigated by the regional diffusion of power. Where royal authority would have been felt most directly is in the regions in close proximity to the Capetian lands, particularly with respect to local government. One of those regions was the “dynamic and powerful” (Hallam E. M., 1980, p. 34) Duchy of Normandy.

Founded in the early tenth century by Vikings (Potts C. , 2002, p. 19), Normandy extended from the Seine basin and the county of Rouen to the west through the Cotentin Peninsula and as far as Mont-St. Michel.<sup>76</sup> In the eleventh century, it was ruled by a ducal household and although seen as a state independent from the French monarchy (Hallam, 1980, p. 37), was ingrained into Western European society, interacting with the kings of England and France, yet still maintaining links to the Viking world.

At the beginning of the eleventh century, Normandy was ruled by Richard II, Duke of Normandy.<sup>77</sup> His siblings and their children were known as “Richardides”, “the hard core of the Norman aristocracy, and the dukes relied on them to govern the duchy” (Neveux, 2008, p. 91).

During Richard’s reign as duke from 996 till 1026, as neighbours, the Capetians and Normans were on good terms. Richard had two sons; one named Richard, the other Robert. When Richard II died, he was succeeded by Richard III. However, Robert contested his brother’s succession and established a shadow government at Falaise. This disagreement lasted a year, until Richard died and was soon replaced by Robert (Douglas, 1964, p. 32). It was around this time (the fall of 1027 or 1028) that William, Robert’s

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<sup>75</sup> There were three French kings in the eleventh century. They were: Robert the Pious, Henry I and Philip I (Bradbury, 1998, p. 44).

<sup>76</sup> A recent article on the subject details how the Norman dukes gained and maintained support in the region. The article also includes several maps and a list of ducal manors which could be brought into a GIS for future research (Hagger, 2012).

<sup>77</sup> His father, Richard I who died in 996 had just been titled count of Rouen.

illegitimate son, was born in Falaise. His mother was Herleva or Herleve, an undertaker or tanner's daughter (Bates, 2008, p. 39; Douglas, 1964, p. 15). Unlike a casual relationship, historians suggest there was a meaningful bond between Robert and Herleva "since her relatives were advanced to positions of some importance at court" (Bates, 2008, p. 41). Following Robert's death in 1035, William became Duke of Normandy at the age of 7 or 8. However, due to his illegitimacy and young age other nobles attempted to assassinate him and seize power for themselves (Douglas, 1964, pp. 37-41). As time progressed, the anarchy of the 1030's and early 1040's evolved into civil war. Two of the main leaders of the revolt were William's cousin, the Richardide Count Guy of Burgundy, and Nigel of the Cotentin (Hagger, 2012, pp. 37-8; Neveux, 2008, p. 115 and 123). It was not until 1047 at the Battle of Val-ès-Dunes with the support of King Henry I of France that William was able to secure control of the duchy (Bates, 2008, p. 48). However, the cordial relationship between King Henry and Normandy was soon to change (Bates, 1982, pp. 59-60).

By 1052, William's rival, the Count of Anjou, replaced William as an ally of Henry I. This change in alliances developed as the king and count saw William as too powerful (Hallam E. M., 1980, p. 74) and undertook to curb his power. Additionally, in 1052, several Norman nobles, including William's uncle Count William of Arques,<sup>78</sup> revolted and enlisted the aid of rival lords to the East of Normandy, at around the same time as the king and Count of Anjou attempted an invasion (Bates, 2008, pp. 61-2). Duke William responded by besieging the rebel count in Arques and defeating the king and the Count of Anjou at the Battle of Mortemer in 1054 (Bates, 2008, p. 62). Henry and the Count of Anjou returned in 1057 but were again defeated by William at the Battle of Varaville. The importance of the Varaville battle was that Normandy was not invaded again until after 1087 (Bates, 2008, pp. 63-4). However, the most important event in this period was the deaths of King Henry and the Count of Anjou in 1060. The removal of these threats provided William with an opportunity to expand his power with fewer external threats

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<sup>78</sup> Count William was another Richardide who harboured ill feelings towards the duke. In fact from 1047 to 1055 Duke William actively tried to exile or depose several prominent Richardides (Neveux, 2008, pp. 123-4).

(Bates, 2008, pp. 59-65). It has been suggested that he unified the Normans through his consistent efforts to militarily dominate the duchy's neighbours including Maine, Ponthieu, the Vexin and Brittany (Hallam, 1980, p. 38; Bates, 2008, pp. 65-71). It is likely that at this point, William turned his attention to England.

At the local level, the duchy was managed through the use of *vicomtes*. These officers were employed to look after “the management, maintenance, and enforcement of the duke's rights” (Hagger, 2007, p. 82).<sup>79</sup> According to Bates, these officials were the Norman equivalent of the English sheriff (Bates, 2008, p. 28). Many of these offices would have gone to the family members of powerful Norman lords who supported the duke (Bates, 2008, p. 50). Thus, William utilized his network of supporters to maintain law and order in his duchy and thus may explain how William maintained his geopolitical power base in Normandy. It also may explain the context for the subsequent Norman Conquest of England. The section below examines the related importance of the demographic and economic standing of the duchy at the time.

#### 4.2.2 Economy and Population

In this section, the economy and population of Normandy will be discussed to further our spatial understanding of the resources potentially available to the Norman army, in further addressing research question 1. Unlike in England's *DB*, there is no economic survey of Normandy from the time of the Norman Conquest. Consequently, in Figures 4.20 and 4.21, an original overview is constructed based upon trade networks, land uses, and settlement development, secured using information provided by the eighteenth century Delisle map.

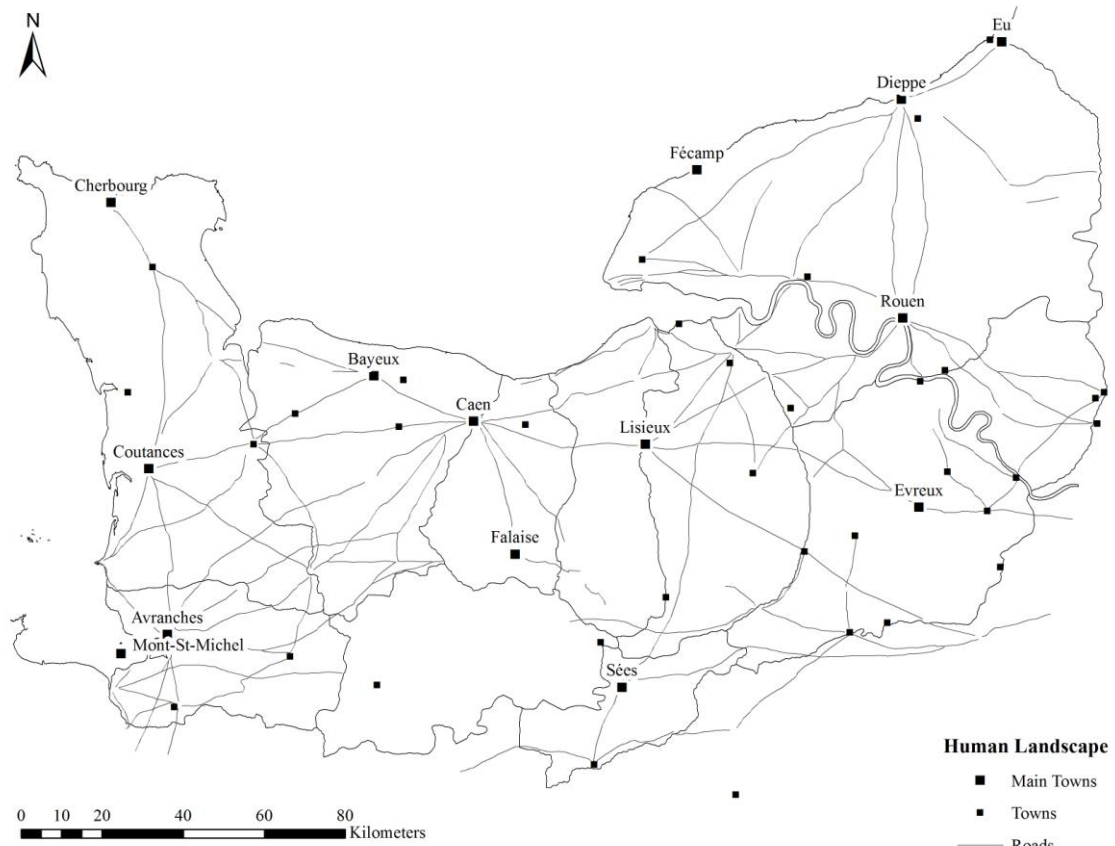
Beyond the local boundaries, this digitization of the Delisle map has focused on tracing out the local roads, rivers and woodland (Figures 4.12 and 4.13).<sup>80</sup> In Figure 4.14, the

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<sup>79</sup> These rights are known as the *Consuetudines et Justicie* as mentioned in Chapter 2.

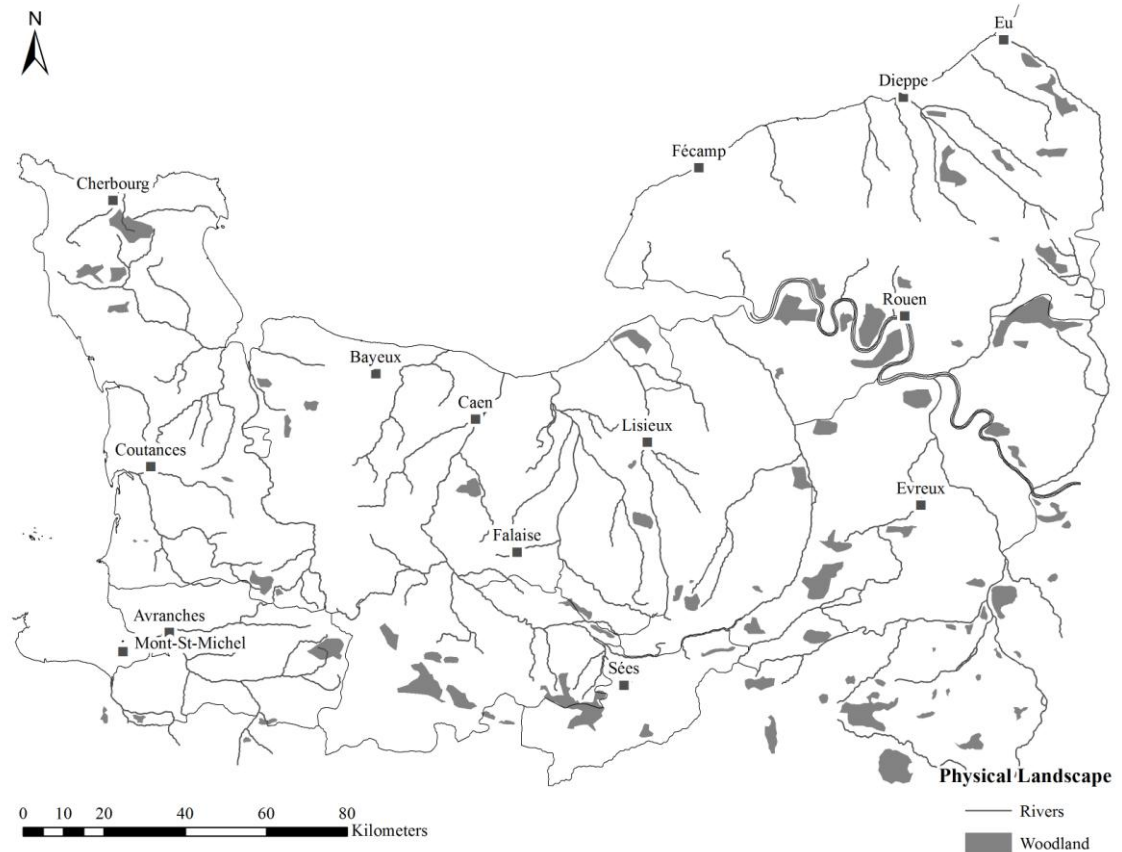
<sup>80</sup> The map indicates the extent of wood in the eighteenth century. For a full extent of the woods in the eleventh, place names would have to be reviewed. For an overview of English woodland place names, see Rackham (1980, pp. 127-30).

major centres were also mapped including the monasteries and castles of the dukes and major land holders (*caput*). This map was developed similarly to the English one (Figure 4.6), with the four categories of town, mint, abbey and bishopric, allowing for a basic comparison with its English counterparts.



**Figure 4.12: Estimated Human Landscape of Normandy in c. 1066 with Main Settlements Labeled<sup>81</sup>**

<sup>81</sup> The roads presented in this figure are derived from the 1716 Map of Normandy as discussed in Appendix A (Cartography Associates, 2012; Delisle, 1716). The towns were selected based upon maps located in several books on the period (Bates, 1982; Huscroft, 2009; Le Patourel, 1976).



**Figure 4.13: Estimated Natural Landscape of Normandy in c. 1066<sup>82</sup>**

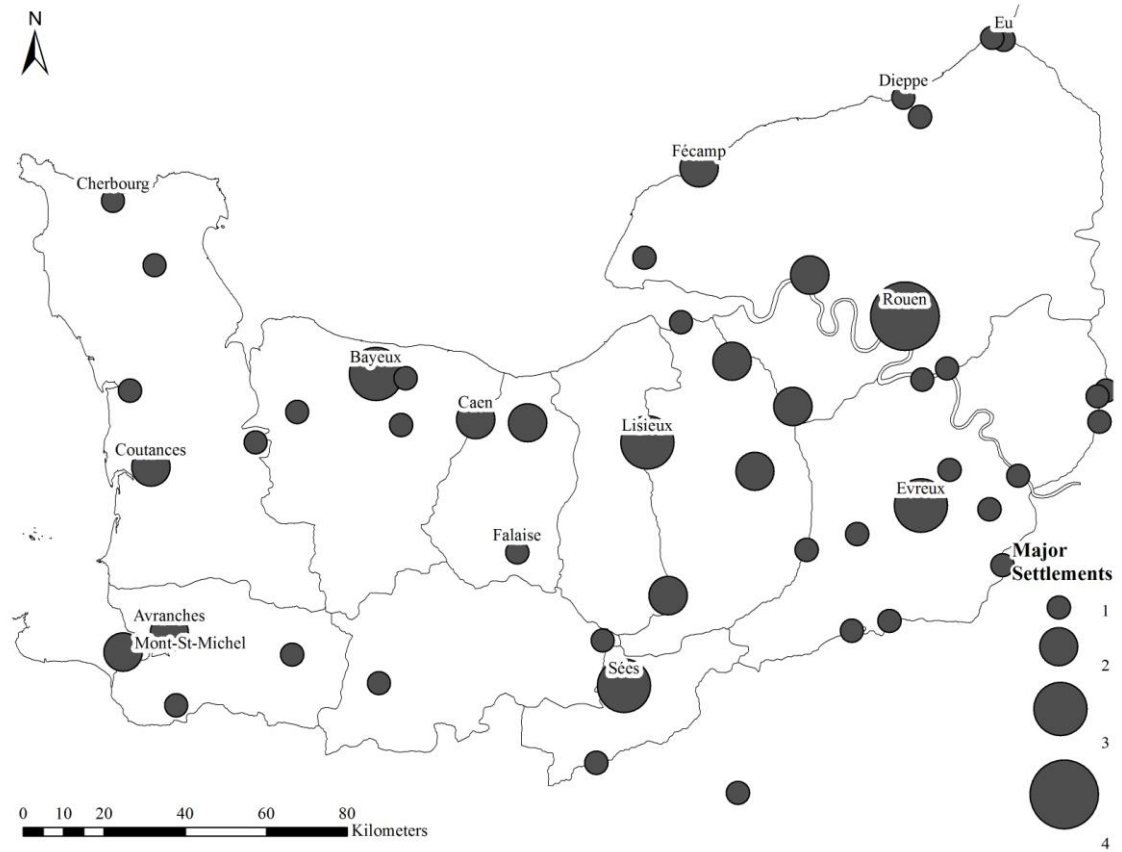
However, unlike in the case of England, there was no available database of major settlements to draw upon for this specific map. Therefore, a unique database was compiled by the author. In this model, unlike the one for England, only “1”s were used for the urban centres. Deciding which centres were urban was based upon maps located in several books on the period such as Huscroft’s on the Norman Conquest (2009), and *Normandy before 1066* (Bates, 1982). *The Norman Empire* provided the most detailed map of the duchy in print and was consulted as well (Le Patourel, 1976). However, as is discussed in Appendix A, the precise sources of these previously published maps are unfortunately infrequently revealed.

<sup>82</sup> The rivers and woodland presented in this figure are derived from the 1716 Map of Normandy as discussed in Appendix A (Cartography Associates, 2012; Delisle, 1716).



With respect to the monastic sites, Bates' map further details the founding date of each monastery, which none of the other maps do. Bates' study was also consulted for the mints, which included only Bayeux and Rouen during this period (1982, p. 128). The merchants in Rouen were particularly important for the Norman Conquest because they assisted in funding the venture. Following the Conquest, these merchants were supported by William (Hollister, Stacey, & Stacey, 2001, p. 149).

Figure 4.14, indicates that there were several key centres in the duchy, notably Avranches, Bayeux, Caen, Coutances, Evreux, Lisieux, Rouen, and Sees. Located between these larger sites were smaller local sites which would have been prominent only at the local level. These sites are also fairly evenly distributed across the duchy with notable exceptions in the sections to the northeast of Rouen and between Falaise and Avranches in the west.



**Figure 4.14: Estimated Development of Major Settlements in Normandy in c. 1066<sup>83</sup>**

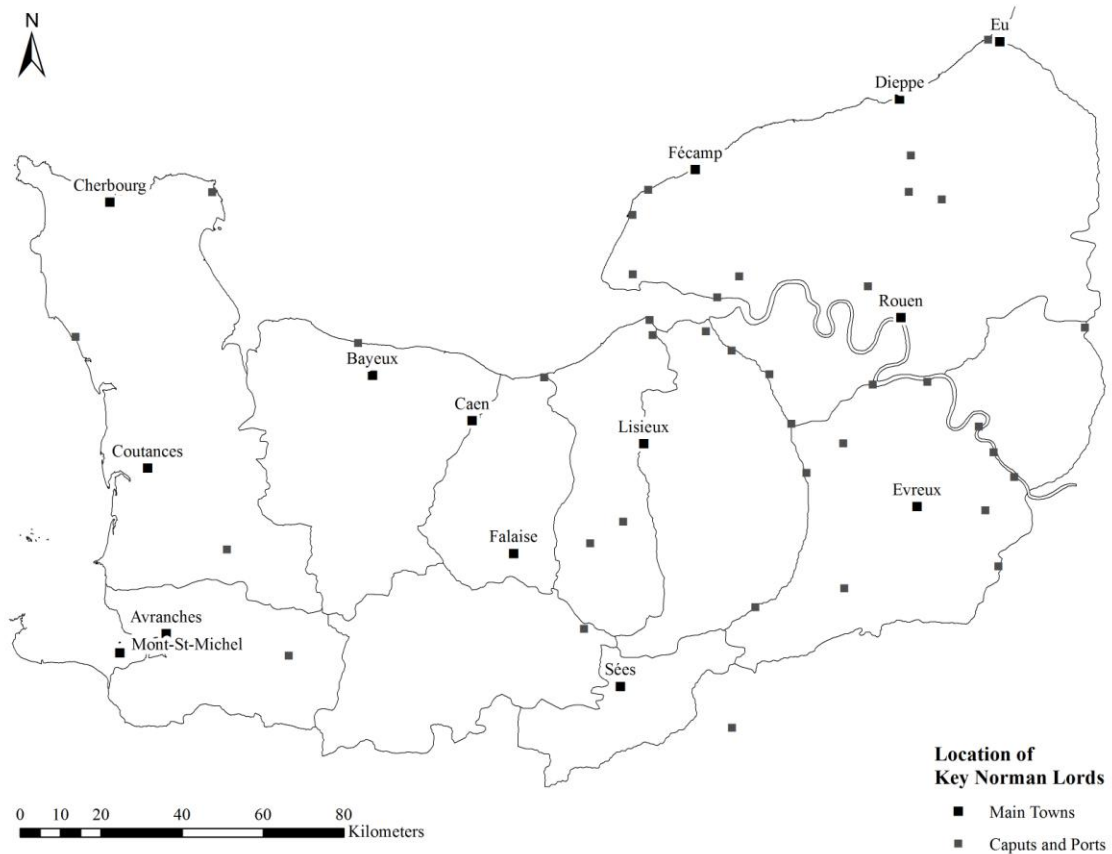
#### 4.2.3 Mobilization and Composition of Army

As is well known from the literature (see Chapter 2), William's army consisted of archers, foot soldiers and cavalry. It is also commonly estimated that the army would have been organized in a similar fashion to the *familia regis* with the cavalry organized around the *conroi*. The *conrois* were likely led by the high ranking nobles or their subordinates. This fact brings a territorial aspect to the army such as the *pagi* or *pays* of the twelfth century (see Appendix A).

The presence of these spatial variables suggests that the organization of the Norman army at Hastings would be ideally analyzed through a geographic lens. Specifically, similarly

<sup>83</sup> This map was derived from a number of references (Bates, 1982; Huscroft, 2009; Le Patourel, 1976).

to the English army, spatial analysis can assist in understanding how William brought his forces together in 1066.



**Figure 4.15: *Caputs* and Ports of Lords Associated with the Norman Conquest in c. 1066<sup>84</sup>**

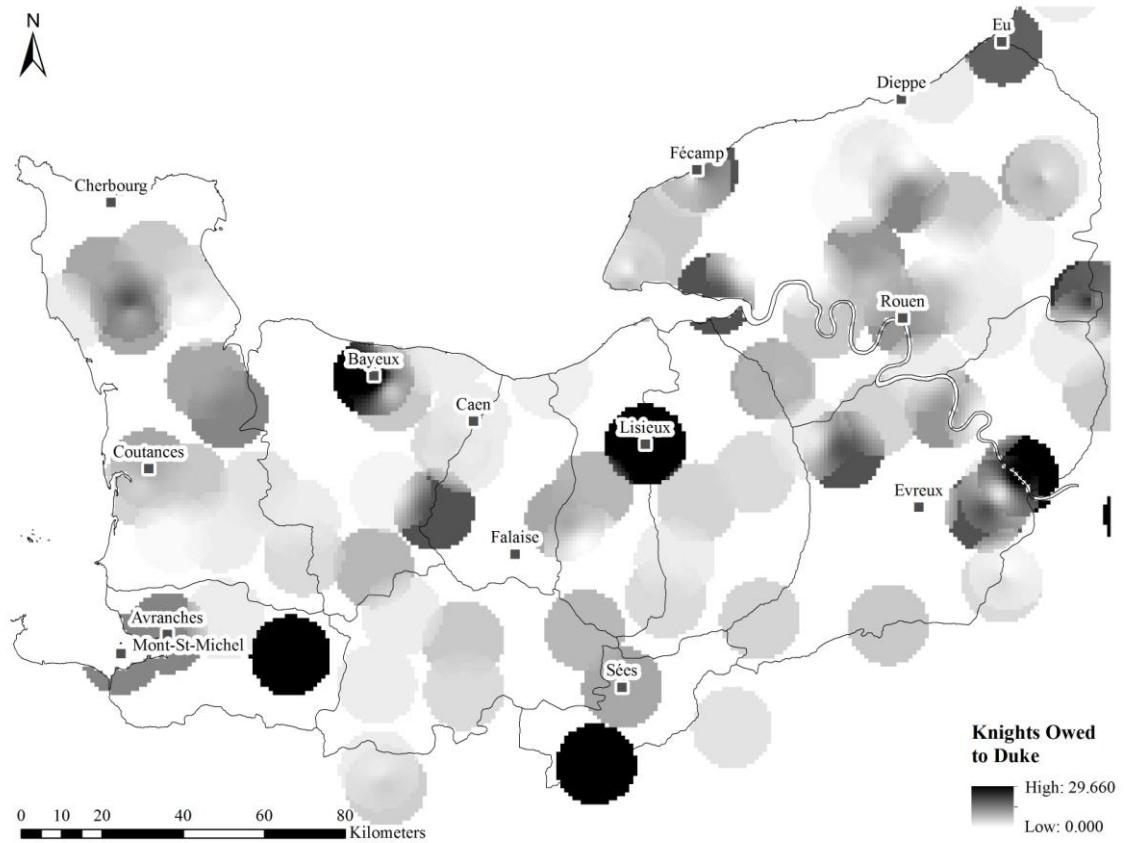
The regions from where the Norman army was derived are assessed through the use of a cartographic model. This model focuses on four factors. The four factors include proximity to the *caputs* of the major Norman lords associated with the Norman Conquest, as well as their ports (Figure 4.15), and woodland, as well as the local rivers (Figure 4.13). A fourth factor on military service is based on the *IM* of 1172.

<sup>84</sup> The list of *caputs* and ports was compiled from several sources (Van Houts E. M., 1987, pp. 169-70 and 178; Douglas, 1943; Thompson, 1987).

The first factor, pertaining to the proximity to the *caputs*, was derived from *WP* as well as interpretations of the ship list and several articles on William's nobility (Van Houts E. M., 1987, pp. 169-70 and 178; Douglas, 1943; Thompson, 1987). The next two factors, concerning woodland and local rivers were traced from the Delisle map (1716). For the final variable, reference needs to be made to the *Infeudationes Militum (IM)* of 1172 (1981). The *IM* records for every major noble, and as depicted in Figures 4.16 and 4.17, the number of knights owed to the duke (Figure 4.16), and the total number of knights (Figure 4.17) on their land (enfeoffed). These two records were then statistically compared to assess if there was a correlation between the two. As both Table 4.2 and Figure 4.18 indicate, a relationship exists between them. However, to ensure reliability in the results, the military service value was based upon a weighted combination of the two variables.<sup>85</sup> The weighting scheme follows the English model with equal weights followed by a higher weight for one variable. The main difference between this model and the English version is that there is some uncertainty about which *IM* variable to use. Therefore, this model will be calculated for equal weights as well as higher weights for either the total number of knights enfeoffed or the knights owed to the duke. This analysis entails 15 calculations as opposed to five. Additionally, similarly to the English model, the standard deviation is then calculated per pixel. The results are discussed with reference to another, earlier study (Hewitt, 2010).

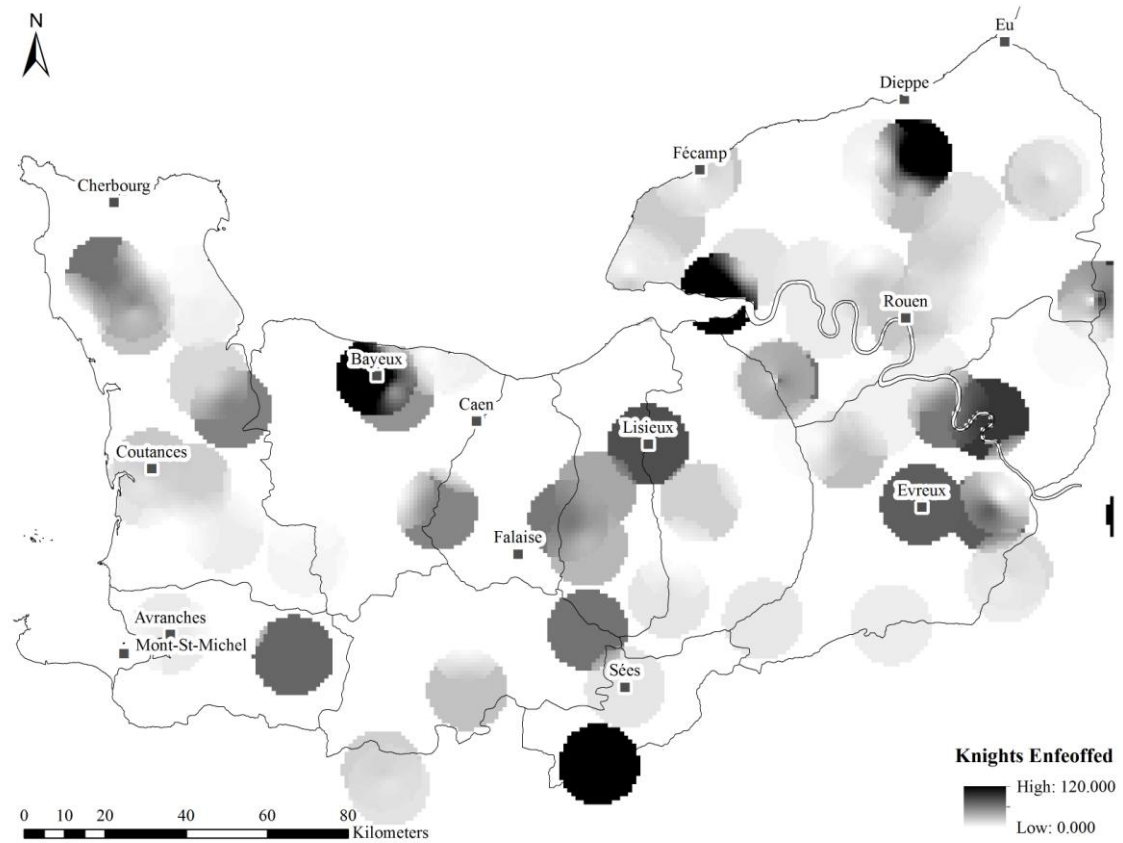
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<sup>85</sup> Since the data presents slightly different spatial trends, the model will be calculated with both weighted equally and then with one weighted more heavily than the other.



**Figure 4.16: Number of Knights owed to the Duke in Normandy from the *IM* of 1172 at a Resolution of 1 km<sup>86</sup>**

<sup>86</sup> Borders are drawn from the Delisle map of Normandy (1716).



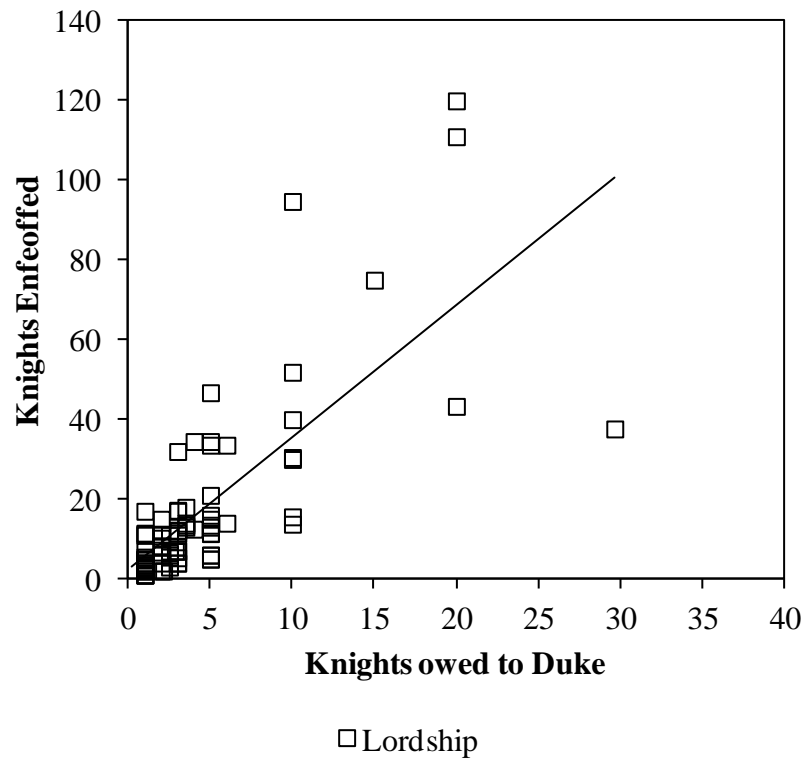
**Figure 4.17: The Total Number of Knights Enfeoffed in Normandy from the *IM* of 1172 at a Resolution of 1 km<sup>87</sup>**

<sup>87</sup> Borders are drawn from the Delisle map of Normandy (1716).

**Table 4.2: Summary of Correlations between the Knights owed to the Duke and the Total Number of Knights Enfeoffed in the *IM* of 1172**

		<b>Knights owed to the Duke</b>	<b>Total Number of Knights Enfeoffed</b>
<b>Knights owed to the Duke</b>	Pearson Correlation	1	0.748**
	Sig. (2-tailed)		0.000
	N	172	88
<b>Total Number of Knights Enfeoffed</b>	Pearson Correlation	0.748**	1
	Sig. (2-tailed)	0.000	
	N	88	104

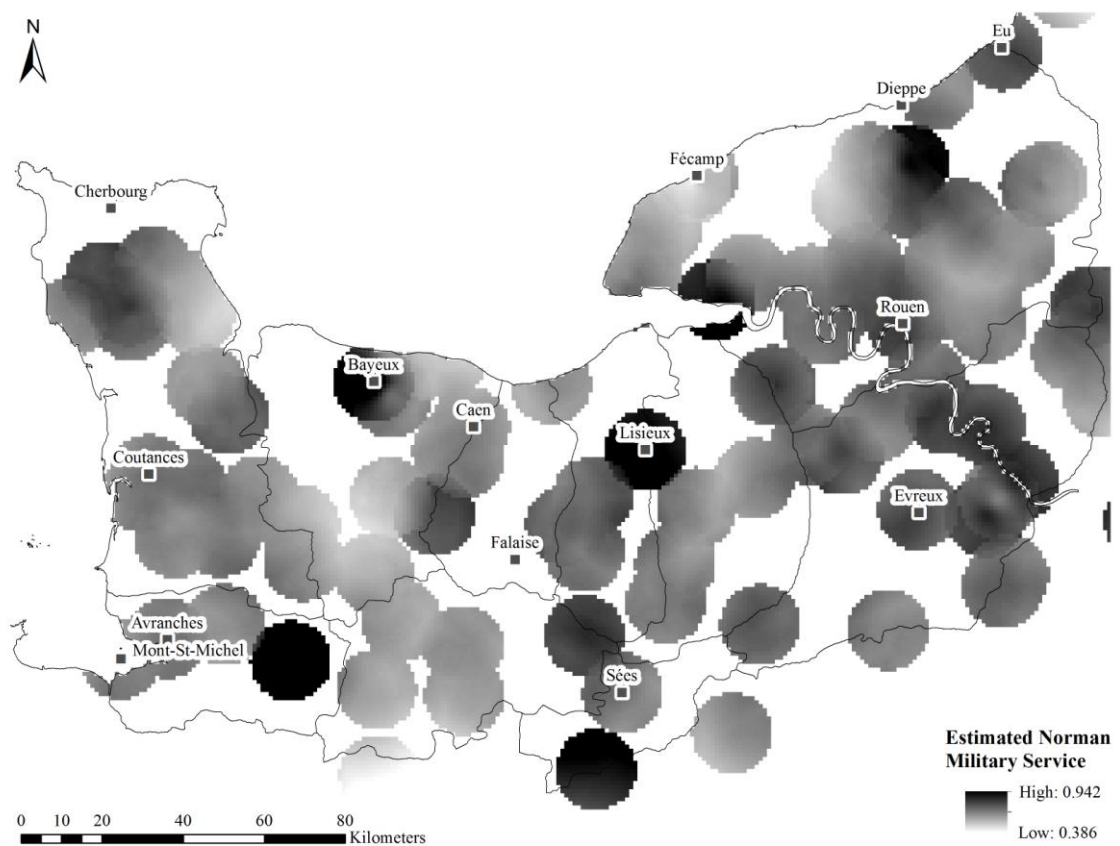
\*\* . Correlation is significant at the 0.01 level (2-tailed).



**Figure 4.18: Scatter Plot and Line of Best-Fit for the Two Variables given in Table 4.2 from the *IM* of 1172**

Based upon the SAW analysis, there are a number of areas from where it is likely William drew his army in 1066 (Figure 4.19). These include the areas surrounding

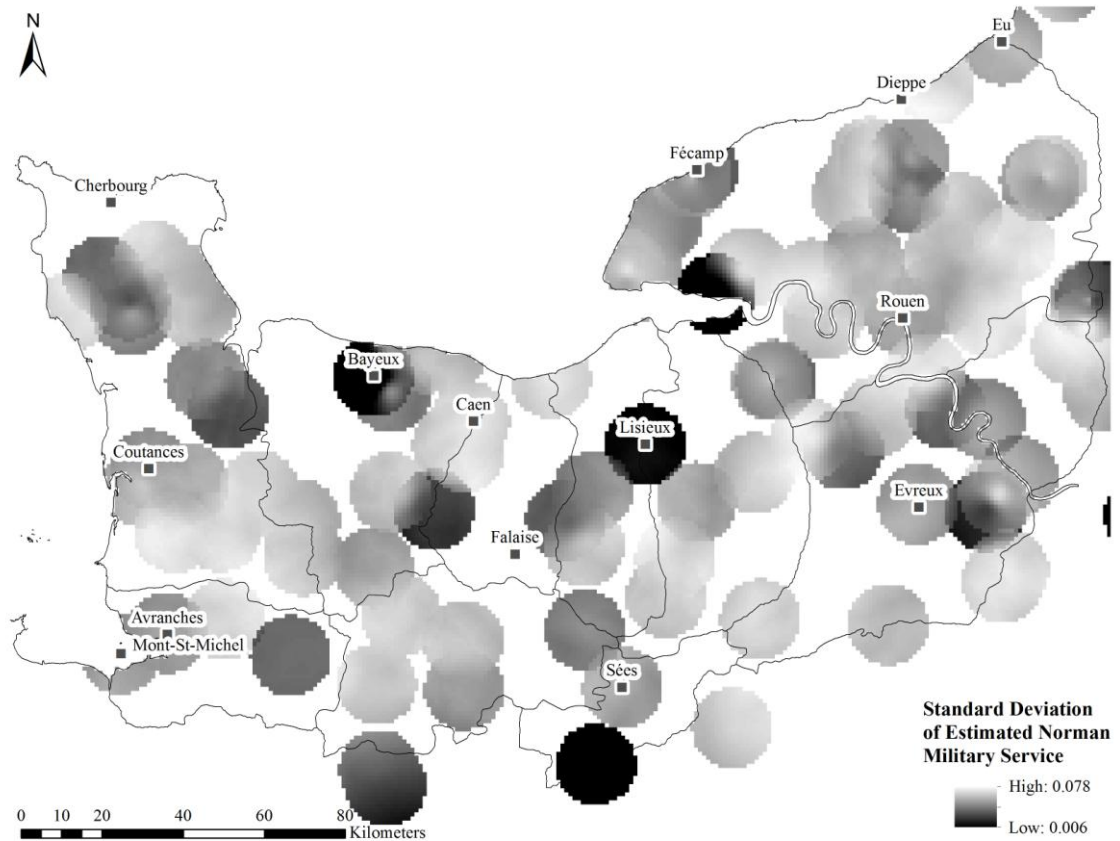
Bayeux, Dieppe, Lisieux, Mortain in the lower west and parts of the Seine River valley. These areas would have been selected based upon their proximity to rivers and or woodland as well as proximity to the *caputs* of the key lords associated with the Norman Conquest. The values in the *IM* of 1172 would have been important as well. Figure 4.20 indicates the standard deviations per pixel. Figure 4.20 reinforces the map in Figure 4.19 by indicating that the areas around Bayeux, Lisieux and the mouth of the Seine River all have low standard deviations, implying that the various weights did not impact the results.



**Figure 4.19: Estimated Likelihood of Norman Military Service at Hastings at a Resolution of 1 km (c. 1066)<sup>88</sup>**

<sup>88</sup> This figure was compiled from a number of sources (Cartography Associates, 2012; Delisle, 1716; Douglas, 1943; *IM* of 1172; Thompson, 1987; Van Houts E. M., 1987, pp. 169-70 and 178).





**Figure 4.20: Standard Deviation of Estimated Likelihood of Norman Military Service at Hastings at a Resolution of 1 km (c. 1066)<sup>89</sup>**

With respect to who actually participated in the battle, Douglas has assembled a list with a brief biography on each individual (1943). This list is based on *WP* and the *BT* with support from the *CHP* (Douglas, 1943, pp. 133-4). Another historical source which provides a larger list of participants is Wace (*RR*, pp. 186-7). However, Douglas believes this list is questionable as most of the names are only a place (1943, p. 131). He further questions some of the lists developed by modern commentators, such as the Falaise Roll, as unreliable (Douglas, 1943, p. 130). The Falaise Roll as presented in the book by M. Jackson Crispin and Leonce Macary examined “the origins of over three hundred people

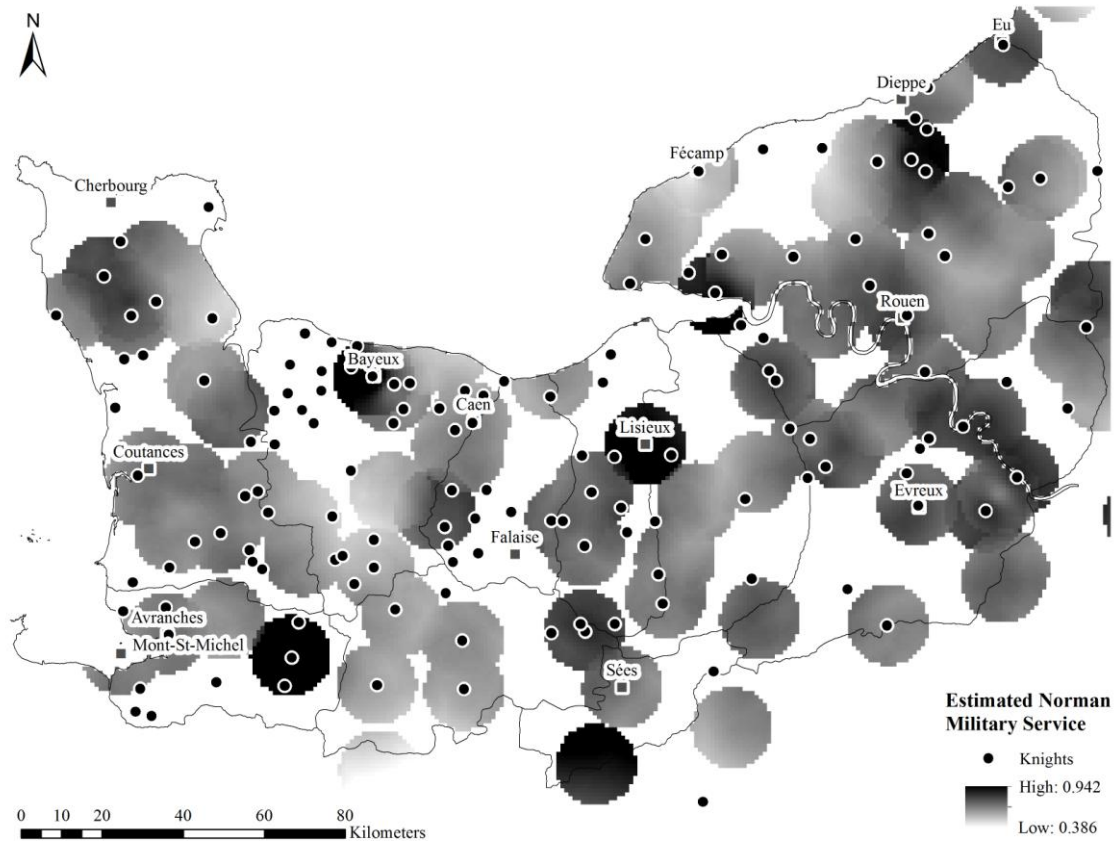
<sup>89</sup> This figure was compiled from a number of sources (Cartography Associates, 2012; Delisle, 1716; Douglas, 1943; *IM* of 1172; Thompson, 1987; Van Houts E. M., 1987, pp. 169-70 and 178).

who are believed to have participated in . . . 1066, including [the] detailed information on the home location of each knight” (Hewitt, 2010, p. 131; Crispin & Macary, 1969).

Hence, following the assumption that the location was more important than simply the place name, an analysis was conducted of the army’s geographical origins.<sup>90</sup> Figure 4.21 displays the results of that analysis along with the SAW results. These results confirm the importance of Bayeux as a centre in the planning of the Norman Conquest. They also suggest less importance be given to the soldiers from Eastern Normandy, despite the fact there are more data from that area in the *IM*. As Hewitt has noted, this could be related to the Richardide faction and past historical events such as the rebellion in 1052 by Count William of Arques (2010, p. 141). In the final analysis, researchers may not know for certain who fought at Hastings but thanks to the geographic analysis undertaken above, there exists a degree of understanding of where they came from and why.

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<sup>90</sup> The locations identified range from southern Brittany to northeastern France. For a cartographic display of this data, see Figure 3 in Hewitt’s article on the subject (2010, p. 138).



**Figure 4.21: Predicted Origins of William's Knights with Estimated Norman Military Service at a Resolution of 1 km (c. 1066)<sup>91</sup>**

In terms of the magnitude of the fighting force, based upon Morillo's assessment of the battle, William likely had a similar number of men as Harold (Morillo, 1990). From 4.1.4, it was estimated that Harold had 2500 professional soldiers, supported by 5000 local soldiers. In William's case, he likely had 2000 cavalry supported by 5500 foot soldiers and archers. William additionally would have had men to garrison the towns of Hastings and Pevensey. Based upon evidence in an article on Anglo-Norman garrisons until 1166, and supported by a text on medieval warhorses, it was estimated that there were two foot soldiers per knight (Hyland, 1998, p. 26; Moore, 1999, pp. 228-32).

<sup>91</sup> This figure was compiled from a number of sources (Cartography Associates, 2012; Crispin & Macary, 1969; Delisle, 1716; Douglas, 1943; Hewitt, 2010, p. 139; *IM* of 1172; Thompson, 1987; Van Houts E. M., 1987, pp. 169-70 and 178).

Considering garrisons between 1047 and 1100, the average number of knights with horses would be approximately 250 which would be supported by an additional 500 foot soldiers (Moore, 1999, pp. 228-9). Thus, a total garrison of 1500 men and 500 horses between Hastings and Pevensey would be a reasonable estimate (Bachrach, 1985, p. 23). Overall, including his garrisons, William likely transported between 7500 and 9000 men to England.

#### 4.2.4 William Sails and Papal Support

Following meetings at Lillebonne, Bonneville and Caen with the Norman nobility,<sup>92</sup> William assembled his force in the summer of 1066 at Dives-sur-Mer (Lawson, 2003, p. 187; Douglas, 1964, pp. 184-5). According to *WP*, he waited a month at Dives due to unfavourable winds (p. 103). From there, it is believed that William intended to sail for England; however he was blown off course by the wind into St. Valery-sur-Somme (*WP*, p. 109) (Lawson, 2003, p. 187; Bradbury J. , 1998, p. 108). William then waited again before sailing to England on September 28 or 29. These pauses in the campaign have been open to debate. Some historians have argued that William was waiting for the English to disband or to see what transpired in the north with King Harald Hardrada (Brown, 1996, p. 201; Gillmor, 1996; Grainge & Grainge, 1996, p. 136; Lawson, 2003, pp. 187-8) while others have suggested that William was entirely at the whim of the weather (Grainge & Grainge, 1996, pp. 136-7). At present, there is evidence for both to be correct. Specifically, as will be discussed below, weather patterns could have impacted the sailing time. William could have also been waiting for the English to disband and when he attempted to sail, was caught in turbulent weather (Grainge & Grainge, 1996, pp. 136-7).

#### 4.2.5 Summary

During the tenth and eleventh century, northern French lords experienced a growth in power at the expense of the French king. In the duchy of Normandy the power relations between the king and duke were cooperative. However, with the succession of William

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<sup>92</sup> It is believed that during these meetings, William assembled the ship list (Chapter 2).

II in 1035 there was a shifting power struggle which through luck and willpower, William survived. Following the deaths of his primary rivals in 1060, William turned his attention to England which was experiencing its own political challenges. In exploring the economy and population, the section focused on the duchy's resources in people, natural landscape features and the network of settlements. With respect to the army at Hastings, this section has illustrated a number of points. The first is that the geographic origins of the army ranged from across the duchy. However, the number of knights who answered the call varied from one region to another due to a number of reasons including political history and loyalties. Nonetheless, this event is a clear demonstration of William's ability to mobilize a force. Thus, "the army of the Norman Conquest was a fair depiction of the duchy" (Hewitt, 2010, p. 142).

### 4.3 Conclusion

Chapter 4 provides the geopolitical context for understanding the events of October 14, 1066. In response to research question 1, it provides a detailed geographical overview, using a number of original maps and figures, to enhance our understanding of the state of England and northern France leading up to 1066. The analysis reveals that the Kingdom of England in 1066 was very much a transition state from the high point of the Anglo-Saxon period to the High Middle Ages. Conversely, the duchy of Normandy, which had come into existence at the beginning of the tenth century, was very much an active player in the politics of northern France with desires for expansion. Review and further geographic analysis with the MCDA models of the local population and economy demonstrated how the respective armies were geographically oriented and the estimated participation at Hastings varied spatially. Thus, there is an indication that although England was likely more powerful, the northern French principalities had desires to expand beyond their borders and the will to do so. Furthermore, with evident internal struggles, England would have appeared to be a worthwhile venture.

Chapter 5 will provide an overview of the topography in the Hastings area and the changes which have occurred since the battle in 1066. Specifically, in an attempt to answer the second research question, Chapter 5 will look at the physical processes and landscape practices which have influenced landscape change to the present day.

## Chapter 5

### 5 Reconstructing the Historical Natural Landscape of the Hastings and Battle Areas

The landscape surrounding contemporary Battle consists of gently rolling hills and mild slopes. The elevation ranges from 35 meters (m) to 85 m and the slopes range between 1 m in 8 m and 1 m in 12.5 m (Lawson, 2003, pp. 51-2). According to Lawson (quoting Hare) this is definitely not the landscape the English and Normans fought over in 1066 (Lawson, 2003, p. 50; Hare, 1980, p. 80).<sup>1</sup> In fact, they claim, it has changed significantly since the time of the battle. But is the presumed battlefield that we see today really that different than what Harold and William witnessed in 1066? To address research question 2, “*how can HGIS inform us about the natural landscape, precipitation and climate of the Hastings area and how they have changed since the battle,*” this chapter will assess and evaluate Hare and Lawson’s claim. In other words, is or is not the present landscape an accurate representation of the historical battlefield?

Combining cartographic and environmental sources with correlations, map and statistical regression, the analysis will be conducted through a study of the local geomorphology, hydrology and soil loss. The local physical processes will be discussed, followed by the local land uses and precipitation back to the time of the battle from the present. The landscape changes will be presented, followed by an analysis of possible sources of error. Finally, the chapter presents the results of a broader erosion analysis, using the RUSLE model which takes into account the land uses, climate and local topography to determine the actual amount of material which has been removed from the area since the battle.

#### 5.1 Physical Landscape Processes

In order to provide a broader context for the analyses to be conducted later in the chapter, this section presents an overview of the physical landscape processes which are

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<sup>1</sup> This comment is important because, Lawson’s book is the standard text on the battle. As such, it is crucial that this fact is explored.

characteristic of the Hastings area. These processes will be outlined below beginning with the local inland geomorphic processes, followed by the hydrologic processes. The coastal geomorphic processes will then be discussed as well.

The study of these processes, or geomorphology, is “the scientific study of the morphology of the surface of the Earth and the processes operating on it, in the present, the past, and the future” (Trenhaile, 2010, p. 1). The two main processes in the Hastings landscape are hillslope and fluvial processes, both of which influence each other.

A hillslope, in its most basic form, is “[t]he vertical change in the elevation of the land surface, when determined over a given horizontal distance” (Kimerling, Buckley, Muehrcke, & Muehrcke, 2009, p. 348; Summerfield, 1991, p. 163). It can be broken down into different elements. On a hillslope cross-section, the top is called the shoulder while the middle is the backslope and the bottom is the footslope. These elements are also curved either as concave (curved inward) or as convex (curved outward) in the landscape, and produce six landscape classifications. A seventh classification is for level slopes (Kimerling, Buckley, Muehrcke, & Muehrcke, 2009, pp. 358-60; Pennock, Zebarth, & de Jong, 1987, p. 303).

Many different types of hillslope processes influence the natural landscape. These processes are typically termed a mass movement which is the “downslope movement of rock and soil in response to gravity” (Trenhaile, 2010, p. 130), and vary in water content as visualized in figure 5.10 of Trenhaile’s book on geomorphology (2010, p. 142). They also vary in speed with some occurring very rapidly while others are more gradual (Summerfield, 1991, p. 168). The main causes of these processes “are the erosivity of the eroding agent, the erodibility of the soil, the slope of the land and the nature of the plant cover” (Morgan, 2005, p. 45).<sup>2</sup>

Most of the hill processes that are acting upon the Battle landscape are slow moving fine particle processes such as landslipping, creep, slumps, slides, and spreads with landslips

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<sup>2</sup> A detailed examination of factors influencing soil erosion can be located in *Soil Erosion and Conservation*, Chapter 3 (Morgan, 2005, pp. 45-66).

the most noticeable (Williams & Robinson, 1983, pp. 35-7; Trenhaile, 2010, p. 135).<sup>3</sup> Faster processes or ones involving high relief such as flows or falls are less likely to occur because of the low relief in the area. Therefore, it is unlikely that large scale hillslope processes would be occurring in this area. In fact, the average amount of soil loss has been estimated at anywhere from 4 to 15 centimeters per millennium (Williams & Robinson, 1983, p. 47). However, these are general estimates for entire drainage basins. For a more detailed estimate consequently, models such as the revised universal soil loss equation (RUSLE) would have to be considered – as is in fact employed later in this chapter (Brady & Weil, 2004, pp. 526-34; Renard, Foster, Weesies, & Porter, 1991). This model is conveniently determined by rain fall, soil erodibility, topography, land use and “erosion-control practices” (Brady & Weil, 2004, pp. 526-7), or in other words, the basic factors influencing erosion as mentioned above.

The chance of a hillslope movement can be determined by calculating the safety factor ( $F$ ). This value is determined by dividing the shear strength by the shear stress (Trenhaile, 2010, p. 135), factors which are a function of the angle, soil cohesion, water presence and weight (Summerfield, 1991, pp. 167-8). For a further discussion of the processes behind hillslope movement, see Summerfield (1991) or Trenhaile (2010). Morgan also provides a detailed discussion on soil erosion processes (2005).

Fluvial processes, on the other hand, occur within a river or stream drainage basin system (Summerfield, 1991, p. 207). According to the Ordnance Survey (2012), small streams have developed in the Battle area. These streams follow a dendritic pattern because they are irregular and the underlying geology does not appear to be impacting the river systems (Summerfield, 1991, p. 407). Within these streams the sediment is eroded and deposited by the stream flow ( $\text{m}^3/\text{s}$ ) (Trenhaile, 2010, p. 305). Gradually, the erosion and deposition rates can lead to features such as meanders which are bends in the river. Further development of meanders can lead to oxbow lakes which are cut off meanders that have silted up. (Trenhaile, 2010, pp. 344-8; Summerfield, 1991, pp. 212-5).

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<sup>3</sup> For a detailed discussion on slow moving processes such as creep, see: *Hillslope: Form and Process* (Carson & Kirkby, 1972) and *Slopes* (Clayton, 1972).



However, with historical landscapes potential human modifications to the fluvial landscape could have occurred and should be considered as well (Rhodes, 2007). For example, straightening a channel can result in increased river erosion. Therefore, humans could have influenced the landscape and the processes occurring on it. To better understand the processes, the local hydrology should be considered as well.

Hydrology is “the geoscience that describes and predicts the occurrence, circulation, and distribution of the water of the earth and its atmosphere” (Dingman, 2008, p. 1). This science is important because water drives most geomorphic processes. For example, rain drops can aid erosion on a hillslope which leads to a very gradual downward movement of soil toward the local river system. This downward movement of sediment assists in the development of gullies in the landscape (Trenhaile, 2010, p. 129). However, these processes are reduced when there is vegetation on the landscape which protects the soil and reduces water erosion (Trenhaile, 2010, p. 127; Williams & Robinson, 1983, p. 35). Mass movement processes in the Battle region as indicated above are likely not fast moving processes. Therefore, the processes are primarily influenced by water content. Thus, the importance of hydrology on hillslope processes is spatially dependent due to potential changes in the relief and variable vegetation (Lawson, 2003, pp. 144-5).

Fluvial processes occur within a river system, which is a flowing body of water (Trenhaile, 2010, pp. 303-4). The driving force behind the fluvial processes is the river itself. River flow is measured as discharge ( $Q$  in  $m^3/s$ ) and it is the volume of water flowing past a specific point at a certain time (Trenhaile, 2010, p. 305). Discharge is typically displayed on a hydrograph (Dingman, 2008; Summerfield, 1991; Trenhaile, 2010). River flow determines the rates of erosion and deposition in the river. It also determines the amount of sediment which is transported as either solution, in suspension or bed load (Summerfield, 1991; Trenhaile, 2010). River flow varies throughout the year depending upon the amount of rain and the amount of water stored in a basin (Summerfield, 1991; Dingman, 2008; Trenhaile, 2010). Therefore, a basic understanding of local river processes can aid in examining the natural changes to the landscape.

The final set of processes which act on the Hastings area are coastal processes. Coastal processes are primarily concerned with the extent of the coast line and the coastal land use changes over time. The main types of coastal processes are waves, tides, storm surges, and currents. “Waves are undulations on a water surface produced by wind action” (Bird, 2008, p. 13). Wind speed indicates the size of the waves so stronger winds will produce larger waves. Therefore, a greater number or particularly severe storms in the English Channel would have more of an effect on the coastal processes than fewer or weaker storms (Bird, 2008, pp. 13-4). Wave refraction occurs when the shape of the coast and the underwater topography has an impact on waves as they near the shore. When the waves arrive at the shore, their energy is what drives the erosion processes (Bird, 2008, pp. 17-22).<sup>4</sup>

The tides vary throughout the year and are based upon the positions of the sun and moon in relation to the earth. When the sun and moon are aligned on one side of the earth then there are particularly high tides (Bird, 2008, p. 26). Conversely, when the sun and moon are not aligned, the tides are lower. Tides can also impact waves by either enhancing or reducing their effect.

“Storm surges occur when strong onshore winds build up coastal water to an exceptionally high level . . . and are most pronounced when they coincide with high spring tides” (Bird, 2008, p. 31). These events are also associated with large waves which can severely erode the coast. These events have been documented in the historical literature. Typically a storm surge can last from hours to a few days (Bird, 2008, p. 31).

Currents which affect the geomorphology of a coast are derived from waves, tides, winds and river estuaries. Sediment above 0.1 mm in diameter can be moved by currents travelling at 15cm/s or more (Bird, 2008, pp. 34-5). However, the main driver for the coastline shape is wave action (Bird, 2008, pp. 34-5).

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<sup>4</sup> For further discussion on waves and the physics behind them, see Bird chapter 2 (2008, pp. 13-14).

In summary, the above processes are the main processes which have been acting upon the Hastings area landscape. It is important to understand these processes as they have a significant influence on local topography.

As mentioned above, the actual amount of erosion occurring in the Battle area can be calculated using the RUSLE model (Beven & Brazier, 2011, p. 52). Before it can be applied, however, two processes require more in-depth examination. These processes are the local land uses, discussed in Section 5.2, and climate, analyzed in Section 5.3. Calculation of the digital elevation models (DEMs) is undertaken in Section 5.4, just prior to the discussion of the final results of the RUSLE equation which is explored in greater detail in Section 5.5.

## 5.2 Land Use

In this section, the changes to the general land use of the area will be regressively explored through the development of six land use maps for both the Hastings and Battle areas, each representing an historical period of change since the battle. These will include Present – 1946, 1945 – 1914, 1913 – 1800, 1799 – 1600, 1599 – 1500 and 1499 – 1066, based upon the period classifications in the ESHER (2013). For this study, the maps were generated from historical maps (Section 2.4), the ESHER (2013) and a previously published interpretation of the data (Bannister, SHLC - II, 2010). This exercise will assist in calculation of the RUSLE model which allows for the determination of erosion, as discussed in the final section of the chapter.

Table 5.1 presents the definitions of the land uses as displayed in Figures 5.1 – 5.12. These land use categorizations were derived from the characterization and interpretation discussions in the *Sussex Historic Landscape Characterization* series (Bannister, SHLC - V, 2010, pp. 32-44). The C value indicates the cover factor for each land use in the RUSLE model. This value was determined from the values reported in Brady and Weil's textbook on soils (2004, p. 531).<sup>5</sup> The RUSLE models' P value (a concept explained in

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<sup>5</sup> The values in the textbook represent values for the Western United States (Brady & Weil, 2004, p. 531). However, in consideration of the land use definitions presented above and in the textbook as well as

Chapter 3) was the most problematic for this study because the literature for this variable was based upon modern day crop-based farming. However, much of this study area is historical and not crop-based. Therefore, it would be incorrect to employ a value designed for the modern landscape to a largely historical manual landscape.

This debate implies that the P values should be estimated. For the purposes of this analysis, this estimation was accomplished by first determining the average P value over several slopes and farming conditions of modern cropland. This calculation provided a set value (0.513) for modern agriculture from which the other land uses / historical periods would be derived.<sup>6</sup> Next, the proportion of the C values to the modern cropland C value (0.159) was determined by land use. Finally the new P values were estimated by multiplying the proportion C value by the set P value (2004, p. 533). In this manner, cropland was deemed to be the most likely to erode and pasture lands less likely to do so.

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equations which defined the values (Renard, Yoder, Lightle, & Dabney, 2011, pp. 145-8), it was concluded that these values would be appropriate for the model.

<sup>6</sup> The P values provided in the soil textbook were averaged for a single value (Brady & Weil, 2004, p. 533).

**Table 5.1: ESHER Land Use Definitions and C / P Values**

ESHER	Definition	C Value	P Value
Coastal	Land that is along the coast and could be flooded at high tide. <sup>7</sup>	0.001	0.003
Communications	Forms of communication typically from the nineteenth century onward.	0.048 – 0.001	0.153 – 0.003
Cropland	Areas which are used for crops.	0.048 – 0.159 <sup>8</sup>	0.153 – 0.513
Designed Landscapes	Areas which were planned such as urban and rural parks.	0.003	0.01
Fieldsapes	Land which is employed for farming or pasture but are unsure which is most correct. <sup>9</sup>	0.025 – 0.081	0.082 – 0.261
Horticulture	Areas designated for growing such as orchards or greenhouses.	0.09	0.291
Industry	Sites currently or formerly employed to extract or process minerals.	0.048 – 0.001	0.153 – 0.003
Military	Defensive structures such as castles.	0.001	0.003
Pasture	Areas for pasture.	0.003	0.01
Reclaimed Marshland	Areas which were formerly marshland – either tidal or freshwater.	0.003	0.01
Recreation	Locations of sporting events such as race tracks or marinas.	0.003	0.01
Settlement	Areas employed for human habitation originating with historical cores.	0.048 – 0.001 <sup>10</sup>	0.153 – 0.003
Unimproved/Unenclosed	Open areas such as common lands.	0.003	0.01
Water	Areas with open water.	0	0
Woodland	Areas covered by trees.	0.001	0.003

Sources: (Bannister, SHLC - V, 2010, pp. 32-44; Brady & Weil, 2004, p. 531)

<sup>7</sup> This land use includes wetlands, saltings, mudflats and dunes (Bannister, SHLC - V, 2010, p. 42). The mud flats and marshes are between the low and high tides while the dunes are above the high tides.

<sup>8</sup> These values are derived from the C values for all agricultural land (modern) and non-mechanized agricultural land (pre-modern).

<sup>9</sup> As it is uncertain what the land was used for historically, this land use has been applied across the area. The C and P values are the difference between the cropland and pasture values.

<sup>10</sup> This value is dependent upon when the local roads were paved particularly in the settlement areas. The roads in the area would not have been paved until the early to mid-twentieth century (Pryor, 2010, pp. 642-3).

### 5.2.1 Developing Historic Land Uses

The first step in developing and graphically presenting the historical land uses was to geo-reference the historical maps. These maps were geo-referenced through the affine transformation (Section 2.4 and 3.2.2). These geo-rectifications typically went through several iterations with points being added or removed until an acceptable RMSE was achieved. For most of this study, the RMSE was between 10 and 20 but some were much lower.<sup>11</sup> These values were considered acceptable because the maps were historical (accuracy may vary) and in some areas there were significant changes to the landscape since the maps were developed, such as in the case of urban Hastings. There were also potential errors in the surveying when the maps were initially drawn. This type of geo-referencing was applied to the maps from 1778 – 1783, 1884 and 1920-1. Detailed cartographic evidence for the land uses, however, dated back only to the later eighteenth century. For maps representing before the eighteenth century, less detailed historical maps were relied upon (Lilley, Lloyd, & Campbell, 2009).

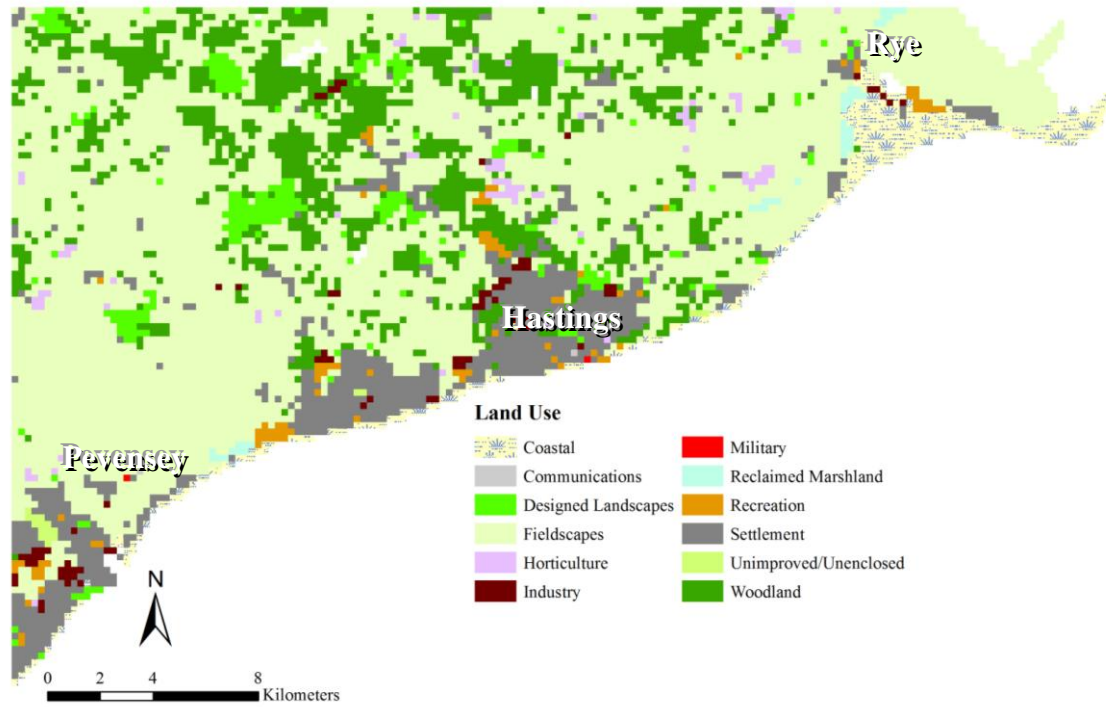
Once the historical maps were geo-referenced, the areas in the ESHER database were classified into the various land uses by period as mentioned above. This classification was based upon the maps or database respectively, and was conducted through several methods. The first was to associate each period with the land uses which were classified as being from that period. For example, woodland classified as early medieval (410 – 1065) was generally assumed to be woodland through the entire study period. This assumption provided a rough starting point for the land uses in each time period. From here the unclassified areas in between the classified ones had to be interpreted. The classification was estimated by overlaying the ESHER map over the geo-referenced historical maps, as discussed above, and setting the map as transparent. This process enabled the historical maps to be seen beneath the ESHER map. Then the land use for each area was re-determined based upon the interpretation of the historical maps. For example, if the historical map indicated woodland, then the corresponding ESHER area

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<sup>11</sup> The geo-rectifications where the RMSE was under 10 were maps with only a small area to be referenced.

was classified as woodland. The interpretation text in the ESHER database was used for the periods before the eighteenth century insofar as no detailed map existed before that point in time.

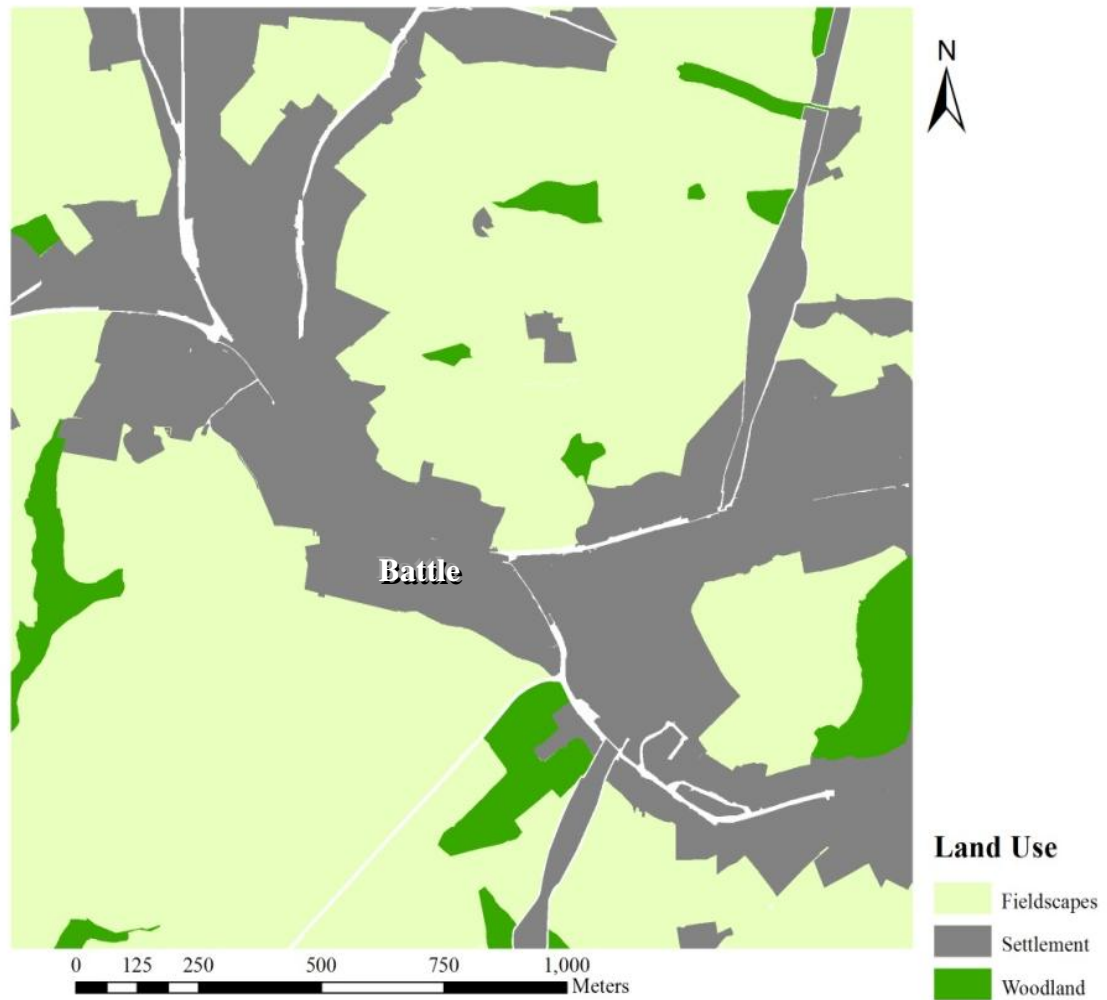
The examination of the land uses begins with the modern land use, as presented in Figures 5.1 and 5.2, which are best viewed in colour. Figure 5.1 reflects the large urban centers from west to east of Eastbourne and Pevensey, Bexhill, Hastings and Rye (inland settlement) on the map (Figure 1.1 for roads). These settlement areas reflect the growth of communities and industry since the end of the Second World War. There are also notable sites of horticulture, recreation and water bodies such as reservoirs. The resolution of the Hastings area map was 250 m by 250 m. This low resolution was selected because a finer resolution “could lead one to the conclusion that we know more than we really do” (Heinen, 1998, p. 189). Additionally, as the data are aggregated and the cells are increased in size, there is a fourfold decline in the number of cells. This fact increases the coarseness of the map which if too coarse could impact the reliability of the results (Bolstad, 2005, p. 41). Figure 5.2 presents the same map except for the Battle area.



**Figure 5.1: Hastings Area Land Uses Present – 1946<sup>12</sup>**

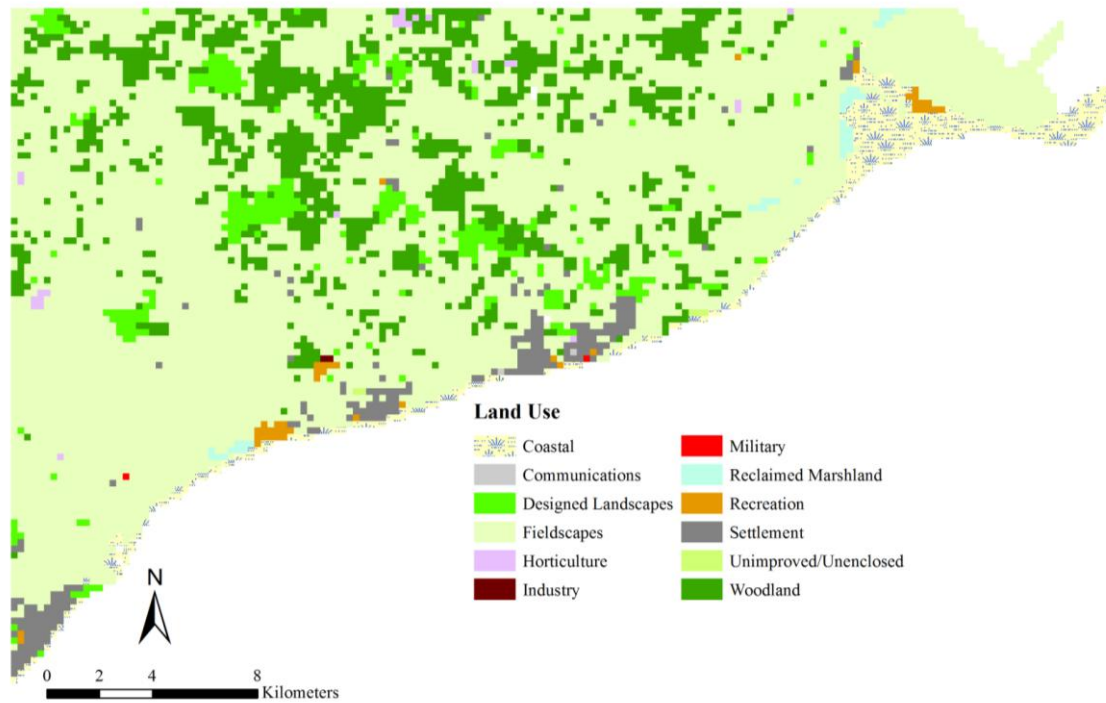
<sup>12</sup> This map is based on the ESHER (2013).





**Figure 5.2: Battle Area Land Uses Present – 1946<sup>13</sup>**

<sup>13</sup> This map is based on the ESHER (2013).



**Figure 5.3: Hastings Area Land Uses 1945 – 1914<sup>14</sup>**

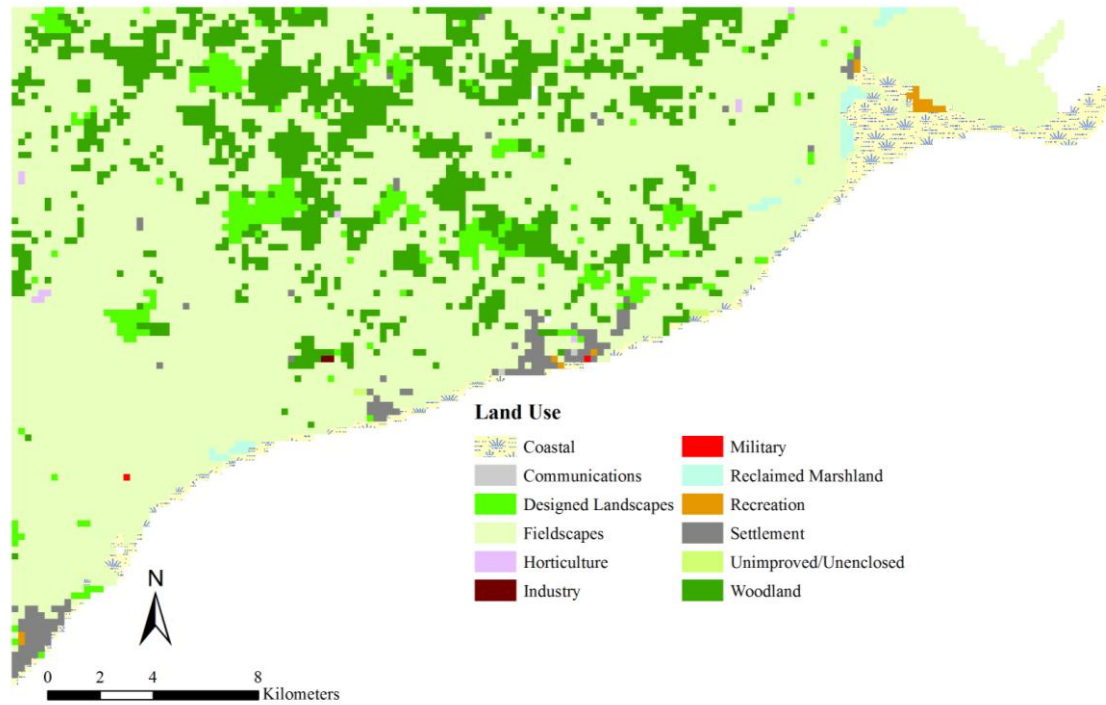
<sup>14</sup> This map was derived from the ESHER and two historical OS maps from the 1920's (Brighton & Eastbourne, 1920; Hastings, 1921; ESHER, 2013).



**Figure 5.4: Battle Area Land Uses 1945 – 1914<sup>15</sup>**

Figures 5.3 and 5.4 represent the land uses in the period between the two world wars of the twentieth century. Compared to the post-war period (Figures 5.1 and 5.2), the main change is in the urban coverage. Development of these maps was based on the evidence in the ESHER as well as two OS maps from the 1920's (Brighton & Eastbourne, 1920; Hastings, 1921; ESHER, 2013).

<sup>15</sup> This map was derived from the ESHER and an historical OS map from the 1920's (Hastings, 1921; ESHER, 2013).



**Figure 5.5: Hastings Area Land Uses 1913 – 1800<sup>16</sup>**

<sup>16</sup> This map was developed from a number of sources including the ESHER, the written comments in the database and two nineteenth century Ordnance Survey maps (ESHER, 2013; Sheet 73 Sheerness and Dungeness, 1969; Sheet 88 Hastings, 1969).

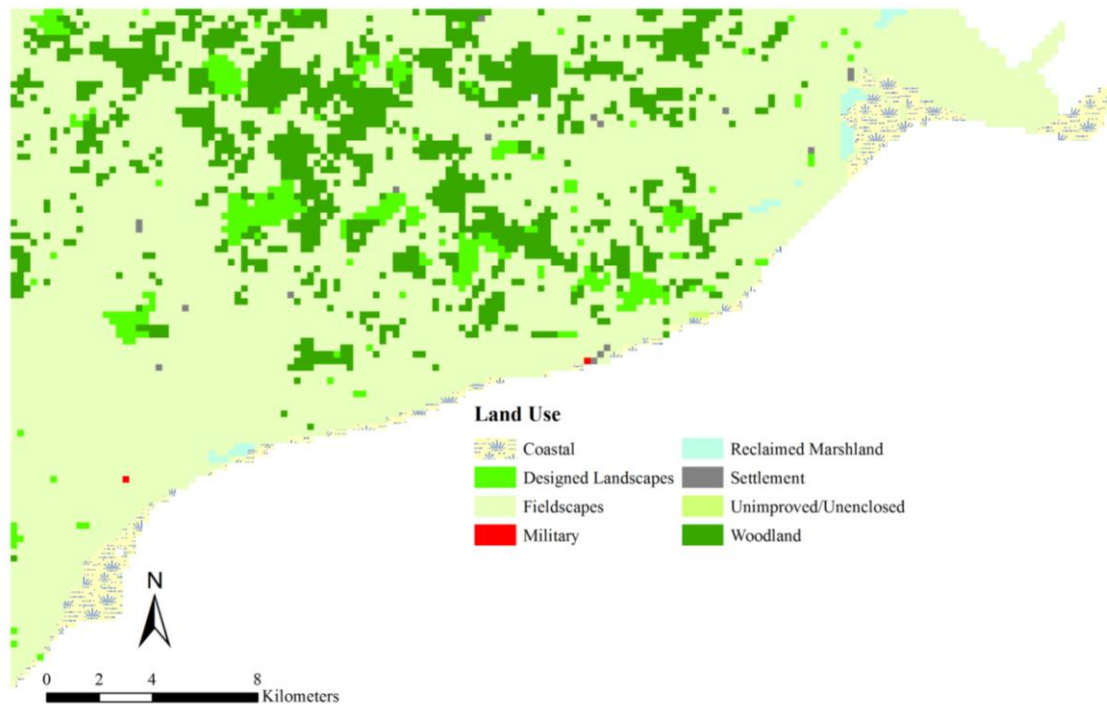


**Figure 5.6: Battle Area Land Uses 1913 – 1800<sup>17</sup>**

Figures 5.5 (Hastings area), and 5.6 (Battle) are based upon findings from the nineteenth century and demonstrate two important changes from the twentieth century. First is the relatively smaller size of the towns along the coast. It was during this time period as well, that recreation, and transportation (such as trains) became important. This map was developed from the ESHER as well as two OS maps from the 1880's which were

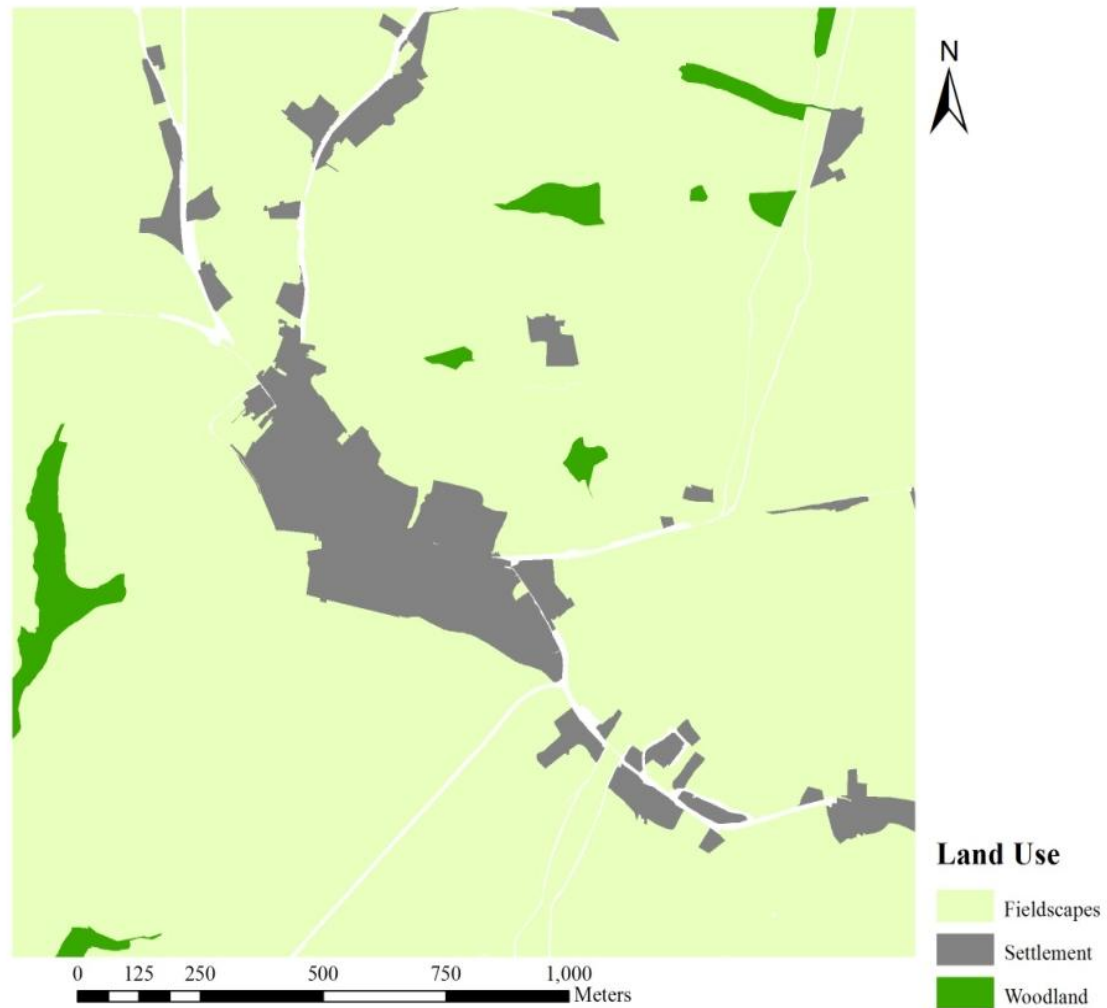
<sup>17</sup> This map was developed from a number of sources including the ESHER, the written comments in the database and a nineteenth century Ordnance Survey map (ESHER, 2013; Sheet 88 Hastings, 1969).

republished in 1969 (ESHER, 2013; Sheet 73 Sheerness and Dungeness, 1969; Sheet 88 Hastings, 1969).



**Figure 5.7: Hastings Area Land Uses 1799 – 1600<sup>18</sup>**

<sup>18</sup> This map is based on the ESHER, written comments in the database and the Yeakell and Gardner map of Sussex (Appendix A; ESHER, 2013; Yeakell & Gardner, 1783).



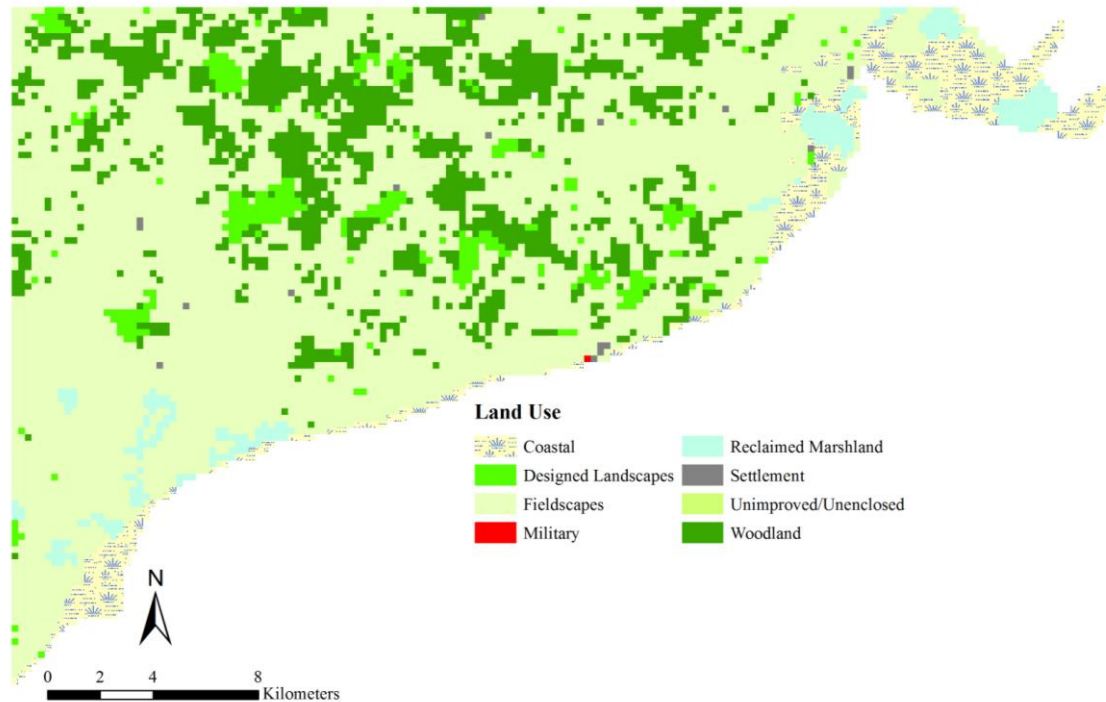
**Figure 5.8: Battle Area Land Uses 1799 – 1600<sup>19</sup>**

The land use maps developed for 1799 – 1600, as presented in Figures 5.7 and 5.8 represent the earliest land uses for which there are detailed historical maps. Aside from a lack of features in both figures associated with the advent of the modern era, Figure 5.7 demonstrates a greater buildup of silt around Rye and Winchelsea and land by Eastbourne (Robinson & Williams, 1983, p. 58). These maps were developed from the

<sup>19</sup> This map is based on the ESHER, written comments in the database and the Yeakell and Gardner map of Sussex (Appendix A; ESHER, 2013; Yeakell & Gardner, 1783).



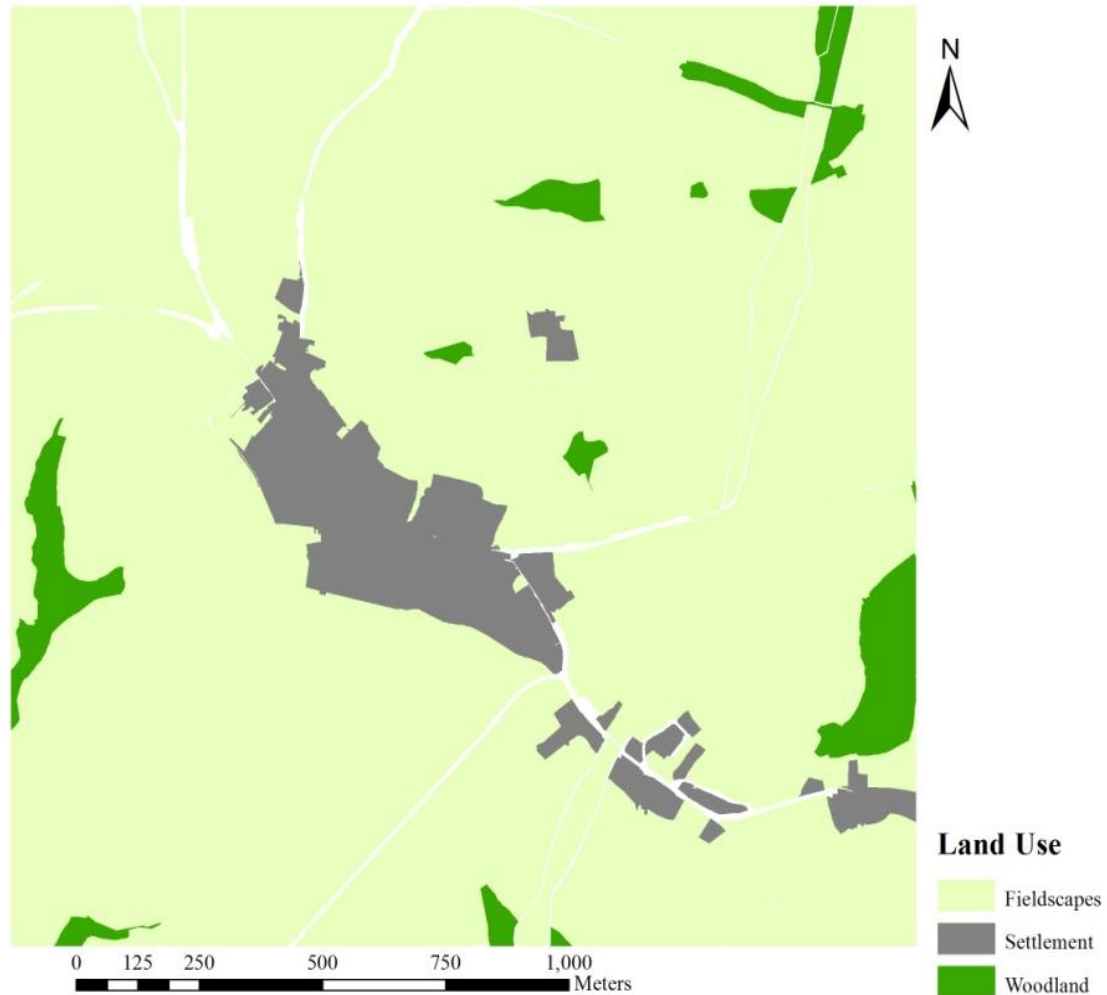
ESHER as well as Yeakell and Gardiner's map of 1783 (ESHER, 2013; Yeakell & Gardner, 1783).



**Figure 5.9: Hastings Area Land Uses 1599 – 1500<sup>20</sup>**

<sup>20</sup> This map is based on the ESHER, written comments in the database and the maps from the fourteenth to sixteenth centuries (Appendix A; ESHER, 2013; Lilley, Lloyd, & Campbell, 2009).





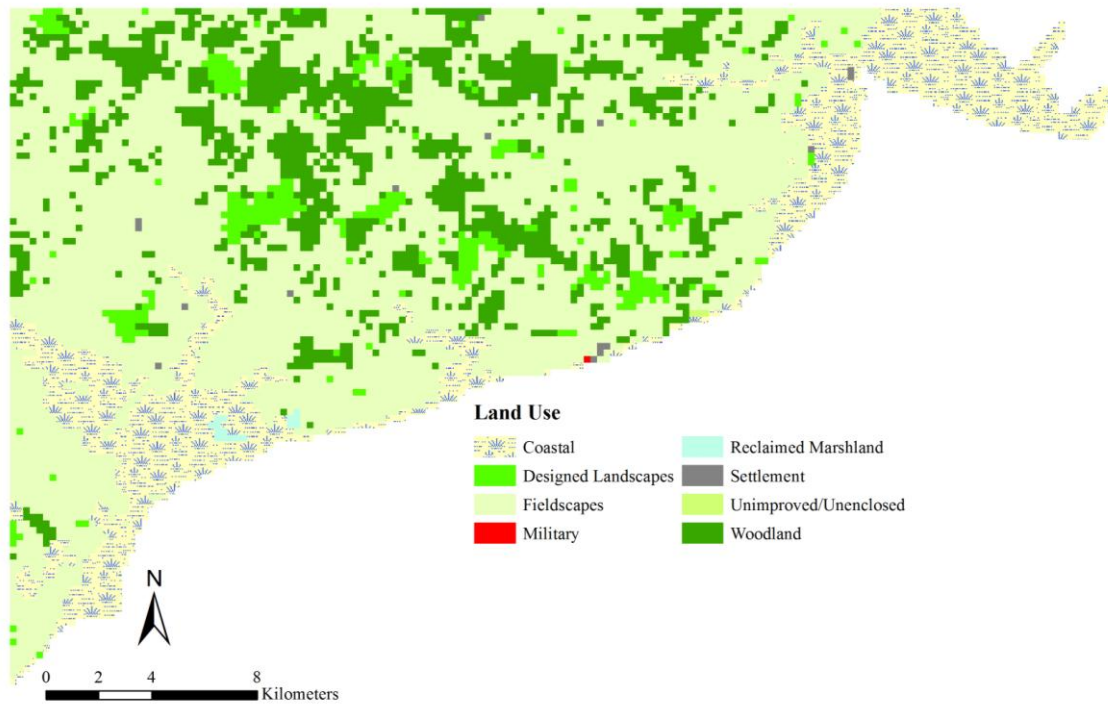
**Figure 5.10: Battle Area Land Uses 1599 – 1500<sup>21</sup>**

Figures 5.9 and 5.10 for the Hastings and Battle areas respectively, offer a less detailed but useful portrait of land uses in the sixteenth century. Figure 5.9 indicates the area surrounding Rye is not land at this time but open water. There also existed extensive areas of reclaimed marshland (Robinson & Williams, 1983, pp. 58-9). In Figure 5.10, the size of Battle appears smaller than in the previous periods. These maps were developed from the ESHER (2013).

<sup>21</sup> This map is on the ESHER and written comments in the database (ESHAR, 2013).

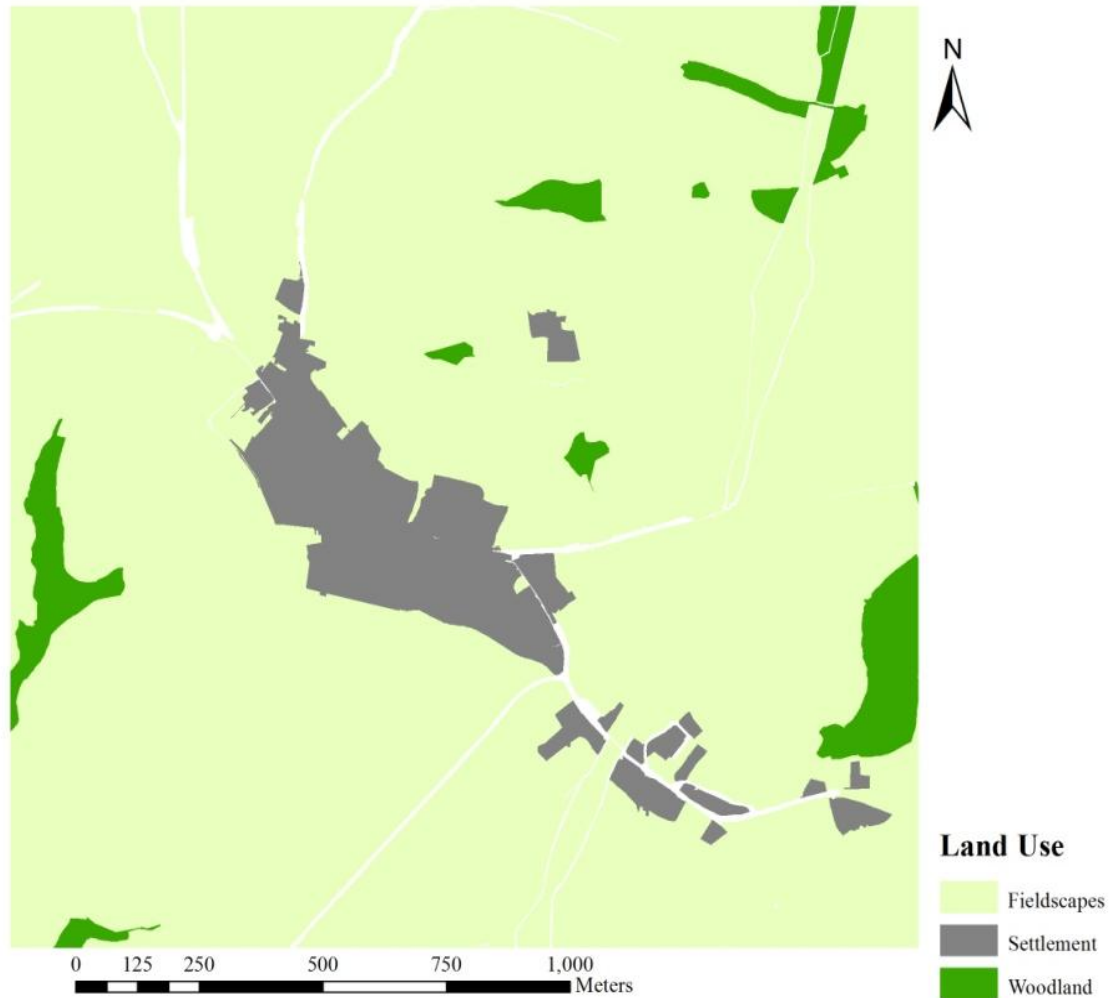
The final two maps as presented in Figures 5.11 and 5.12, reflect the medieval land use from 1499 until 1066 and are based on the ESHER, written comments in the database and a map from the fourteenth century (ESHER, 2013; Lilley, Lloyd, & Campbell, 2009). Given the available data for this period, these figures represent an approximation of the land use in the late medieval period with the large cell resolution in Figure 5.11, a reflection of this fact. The subsequent figure, Figure 5.12 represents the land uses for the Battle area for the same time period. Figure 5.11 indicates that a large portion of the area was woodland in this period with intermixed agriculture. Small settlements had developed on the landscape as well as a small number of castles such as Hastings and Pevensey (Bradbury, 1998, pp. 87 and 122-3).

Figure 5.11 also reveals the expanse of the arable land in the middle ages, reflecting the population increase in the early part of this period. Some of this land represented woodland clearances known as assarts which were transformed into arable or pasture (Hoskins, 1977, pp. 86-7; Rackham, 1980, p. 134). However, following droughts and disease, especially the Black Death in the mid-fourteenth century, the population declined and the areas of arable land decreased (Bennett & Hollister, 2006, pp. 326-30).



**Figure 5.11: Hastings Area Land Uses 1499 – 1066<sup>22</sup>**

<sup>22</sup> This map is based on the ESHER, written comments in the database and a map from the fourteenth century (Appendix A; ESHER, 2013; Lilley, Lloyd, & Campbell, 2009).



**Figure 5.12: Battle Area Land Uses 1499 – 1066<sup>23</sup>**

### 5.2.2 Limitations

One of the main limitations in undertaking the regressive reconstruction above is the sources of error associated with the use of historical maps. For example, in attempting to geo-reference the older maps to the modern landscape, existing road networks were of little use as frequently they did not match the historical road network. Therefore, fewer points could be added to the older maps and thus, they could not be precisely referenced.

<sup>23</sup> This map is based off of the ESHER and written comments in the database (ESHER, 2013).

A second limitation relates to the difficulty in classifying land uses. This was particularly true in Pevensey Levels because a comprehensive study of the landscape does not exist unlike the Rye / Winchelsea area, Coombe Haven or Eastbourne. For example, in Gravett's book on the battle, Pevensey Levels is depicted as shallow open water (1992, pp. 50-1). However, if historical maps from the fourteenth to the seventeenth centuries are consulted, it is not open water but marshland. Furthermore, according to Brandon, Pevensey Levels in the medieval period consisted of a shingle dyke and a massive salt marsh behind which flooded at high tide (1974, p. 111). Therefore, Pevensey should not be considered as open water but more akin to a large marsh with loosely defined fluvial channels (Appendix A).

Another source of error comes from the time periods for the land uses. For example, the medieval land use spans from 1066 to 1499, which is over 400 years (ESHER, 2013). Therefore, this classification covers all the developments of the period. Thus, as mentioned previously, this land use likely represents a value closer to the maximum extent of arable in the medieval period.

## 5.3 Climate

Another critical variable in the development of the RUSLE model is climate. In this section, the climate at the time of and since the Battle of Hastings will be explored through the development of precipitation graphs of the local region, as well as reference to written accounts. The analysis in this section relies on contemporary sources as well as environmental precipitation reconstructions and measurements (as discussed in Section 2.5 of the literature review).

### 5.3.1 Precipitation Change since the Battle

Two fluvial systems drain the Battle area and they are the Brede and Crowhurst (CEH, 2013). However, only the Crowhurst system possessed precipitation records for any length of time with over 40 years of observations, as opposed to the Brede with less than a decade of observations. Therefore, to ensure the Crowhurst sample was representative of the area, years where both systems had records were compared with a correlation test. The output from this test is displayed below in Table 5.2, which indicates there is a high

degree of correlation between the datasets. Thus, statistically speaking, the Crowhurst sample is representative of the area.

The most effective method of graphically representing precipitation is with a climograph. A climograph “plot[s] daily, monthly or annual temperature and precipitation values for a selected station; may also include additional weather information” (Christopherson, 2004, p. 555). A climograph for the Hastings area was developed for this study and is depicted in Figure 5.13 (Met Office, 2013; CEH, 2013). This figure indicates a general trend, over the last 40 years, of heavier rainfalls in the fall with the least in the spring and summer.<sup>24</sup> Given the long term invariability of precipitation change generally, it is anticipated that this general yearly trend would be applicable back to the time of the Norman Conquest.

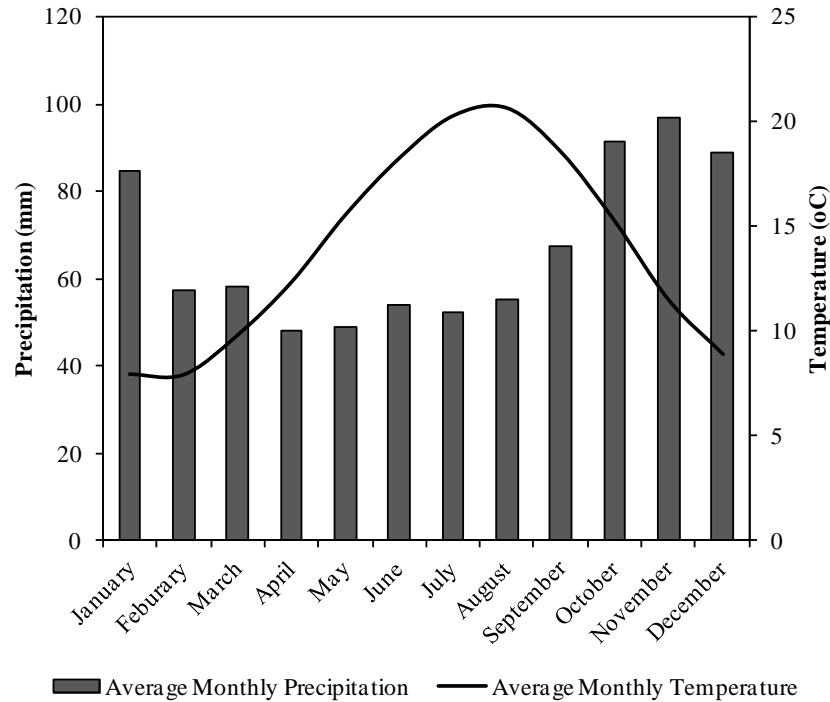
**Table 5.2: Correlations between the Brede and Crowhurst Precipitation Measurements (2004 – 2011)**

		<b>Brede</b>	<b>Crowhurst</b>
<b>Brede</b>	Pearson Correlation	1	.979**
	Sig. (2-tailed)		.000
	N	96	96
<b>Crowhurst</b>	Pearson Correlation	.979**	1
	Sig. (2-tailed)	.000	
	N	96	96

\*\* . Correlation is significant at the 0.01 level (2-tailed).

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<sup>24</sup> This trend can also be seen with local hydrographs (Potts, Browne, & Rendell, 1983, p. 69). Hydrographs will be explored in more detail in Chapter 6.



**Figure 5.13: Average Precipitation of Battle UK / Temperature of Eastbourne UK (1970 – 2011)<sup>25</sup>**

With respect to precipitation volumes, as discussed in Section 2.5, there are two historical precipitation datasets which date back to before the Battle of Hastings, developed for Southern-Central England (Wilson, et al., 2012) and East Anglia (Cooper, et al., 2012), respectively. Table 5.3 presents the correlation coefficients between the annual precipitation and two precipitation reconstructions and an average between the two. The first column presents the raw data while the second and third columns present three and five-year running means of the datasets (Cooper, et al., 2012; CEH, 2013; Wilson, et al., 2012). Based upon these correlation tests, the data which optimally approximated the Hastings annual rainfall was a three year running mean of the data from Cooper et al.'s paper (2012). Therefore, the annual precipitation values could be estimated from this data and are explored further statistically in Tables 5.4 to 5.6. Table 5.4 presents a model

<sup>25</sup> As measured in Google Earth, Eastbourne is just over 21 km from Battle and the temperatures are expected to be similar (Met Office, 2013; CEH, 2013). Other climographs for the area can be seen in Potts & Browne's chapter on climate (1983, p. 94 and 99).

summary with the  $R$  and  $R^2$  values. Table 5.5 presents an ANOVA analysis of the regression. The analysis indicates that the  $F$ -statistic is significant which implies the modeled precipitation explains a significant amount of the variability in the measured annual precipitation. The final table, Table 5.6 presents the coefficients for the model. As indicated with the ANOVA test, the coefficient of the modeled precipitation from Cooper et al., (2012) is significant in the model. Therefore, the Cooper et al., (2012) March to July precipitation values can be interpolated into annual values.

The annual values were achieved by first calculating a three-year running mean from 1065 until 2006 for the Cooper et al., (2012) data. This analysis yielded values from 1066 until 2005. These values were then multiplied by the precipitation coefficient of 2.303 and then added to the constant of 222.708 (Table 5.6)<sup>26</sup> to generate the predicted annual values. These values were then averaged by decade, providing 94 decades of measurements. This data was summarized in Figure 5.14 with the minimum and maximum per decade as well (Cooper, et al., 2012).

**Table 5.3: Pearson Correlation Coefficients between Recorded Precipitation (Columns) and Estimated Precipitation (Rows) for the Hastings Area (1970 – 2009)**

		<b>Annual Precipitation</b>	<b>Annual Precipitation 3 Year Mean</b>	<b>Annual Precipitation 5 Year Mean</b>
<b>Precipitation (Wilson et al)</b>	Pearson Correlation	0.227	0.472**	0.419*
	Sig. (2-tailed)	0.159	0.003	0.011
	N	40	38	36
<b>Precipitation (Cooper et al)</b>	Pearson Correlation	0.360*	0.595**	0.538**
	Sig. (2-tailed)	0.023	0.000	0.001
	N	40	38	36
<b>Average Modeled Precipitation</b>	Pearson Correlation	0.288	0.560**	0.516**
	Sig. (2-tailed)	0.072	0.000	0.001
	N	40	38	36

\*\*. Correlation is significant at the 0.01 level (2-tailed).

\*. Correlation is significant at the 0.05 level (2-tailed).

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<sup>26</sup>  $y = 2.303x + 222.708$



**Table 5.4: Regression of Annual Recorded Precipitation verses Cooper et al.****Precipitation Model Summary (1970 – 2009)<sup>27</sup>**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.595 <sup>a</sup>	0.354	0.336	69.261

a. Predictors: (Constant), Precipitation (Cooper et al March - July)

**Table 5.5: Regression of Annual Recorded Precipitation verses Cooper et al.****Precipitation ANOVA (1970 – 2009)**

Model <sup>a</sup>		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	94584.227	1	94584.227	19.717	0.000 <sup>b</sup>
	Residual	172692.654	36	4797.018		
	Total	267276.881	37			

a. Dependent Variable: Annual Precipitation

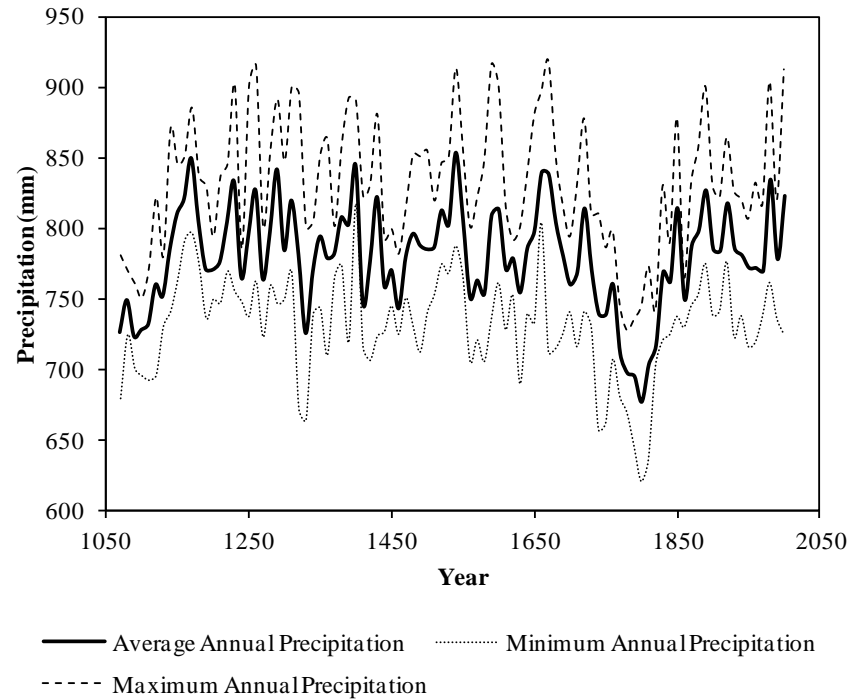
b. Predictors: (Constant), Precipitation (Cooper et al March - July)

**Table 5.6: Regression of Annual Recorded Precipitation verses Cooper et al.****Precipitation Coefficients (1970 – 2009)**

Model <sup>a</sup>		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	222.708	131.389		1.695	0.099
	Precipitation (Cooper et al March - July)	2.303	0.519	0.595	4.440	0.000

a. Dependent Variable: Annual Precipitation

<sup>27</sup> The captions of Tables 5.4 – 5.6 is based on an example presented in Rogerson's statistics text (2010, pp. 218-9).



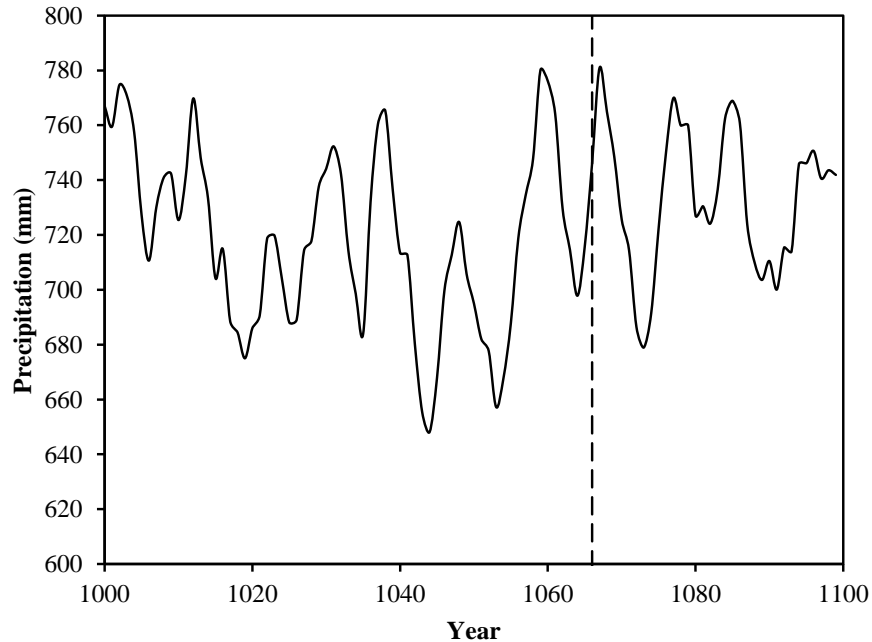
**Figure 5.14: Annual Precipitation for the Hastings Area since 1066 by Decade<sup>28</sup>**

As figure 5.14 demonstrates, the precipitation in the area since the battle has varied roughly between 750 and 850 mm per year. However, in the early nineteenth century, there was a drier decade with less than 700 mm of rain on average per year. The significance of this pattern for the RUSLE model will be explored in Section 5.5.

With respect to the eleventh century a number of patterns may be observed, as depicted in Figure 5.15, which was developed using Cooper et al.'s data (2012). The figure indicates that precipitation levels varied throughout the eleventh century between 650 mm and 780 mm. During the time of the battle precipitation levels appear to have been near or at their peak which may have had an impact on the battle as is discussed in Chapter 7.

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<sup>28</sup> Calculated with the model above (Tables 5.4 – 5.6) (CEH, 2013; Cooper et al., 2012).



**Figure 5.15: Estimated Yearly Precipitation in the Eleventh Century Hastings Area<sup>29</sup>**

### 5.3.2 Limitations of Climatic Data

The climatic data presented in the previous sections contain several limitations. The first originates from the  $R^2$  value associated with the correlation between the Crowhurst precipitation values and Copper et al.'s data, as presented in Table 5.4, which is low at around 0.354. This statistic indicates that the fit is rudimentary despite the evidence that the data is significant. Therefore, the selected precipitation record could be incorrect in estimating precipitation of this location back to the medieval period. However, these data are the most up-to-date datasets for climate reconstruction in England back into the medieval period.<sup>30</sup> This possible error will be taken into account in the development of the RUSLE model in Section 5.5.

<sup>29</sup> Calculated with the model above (Tables 5.4 – 5.6) (CEH, 2013; Cooper et al., 2012).

<sup>30</sup> Upon consultation with several climatologists (Drs. Brian Luckman, Katrina Moser and Rob Wilson in January of 2013) and an examination of the literature on the subject, the author concluded that this dataset was the most reliable for the study.

### 5.3.3 Written Sources

Models of climatic change during the period of the battle are in some measure supported by written sources, and in fact, weather during the Hastings campaign has been mentioned in several sources on the battle. The most vivid is the *CHP* which indicates the weather at the time of William's voyage to England.

It was cold and wet and the sky was hidden by clouds and rain. But Almighty God . . . drove the clouds from the sky and the winds from the sea; he dispelled the cold and cleansed the heavens of rain. The earth became warm, bathed in great heat; and the sun shone with unusual brilliance. The festival of St Michael [29 Sept.] was about to be celebrated throughout the world when God granted you [William] everything according to your desires (*CHP*, p. 7).

As shown in Figure 5.13 above, there probably could have been precipitation in the weeks prior to the crossing as this quote suggests. In addition, based upon their own meteorological analysis of the period, Grainge and Grainge have affirmed the accuracy of the *CHP*'s assessment of the weather as part of a broader consideration of the document as a contemporary source of the Battle (1996, p. 142). Additional weather references from *WP*, who makes several mentions referring to the wind at the time. For example, it is explicitly stated that "unfavourable winds delayed him [William] for a month at the mouth of the Dives [river]" (*WP*, p. 103). *WP* also indicated that William was "[c]arried by a favourable breeze to Pevensey" (p. 113). William of Jumièges also comments on the winds indicating that William, "with favourable wind and sails billowing aloft . . . crossed the sea and landed at Pevensey" (*GND*, pp. 165-7). Overall, these comments confirm the statement in the *CHP* that the winds changed in William's favour.<sup>31</sup>

## 5.4 Simplifying DEMs

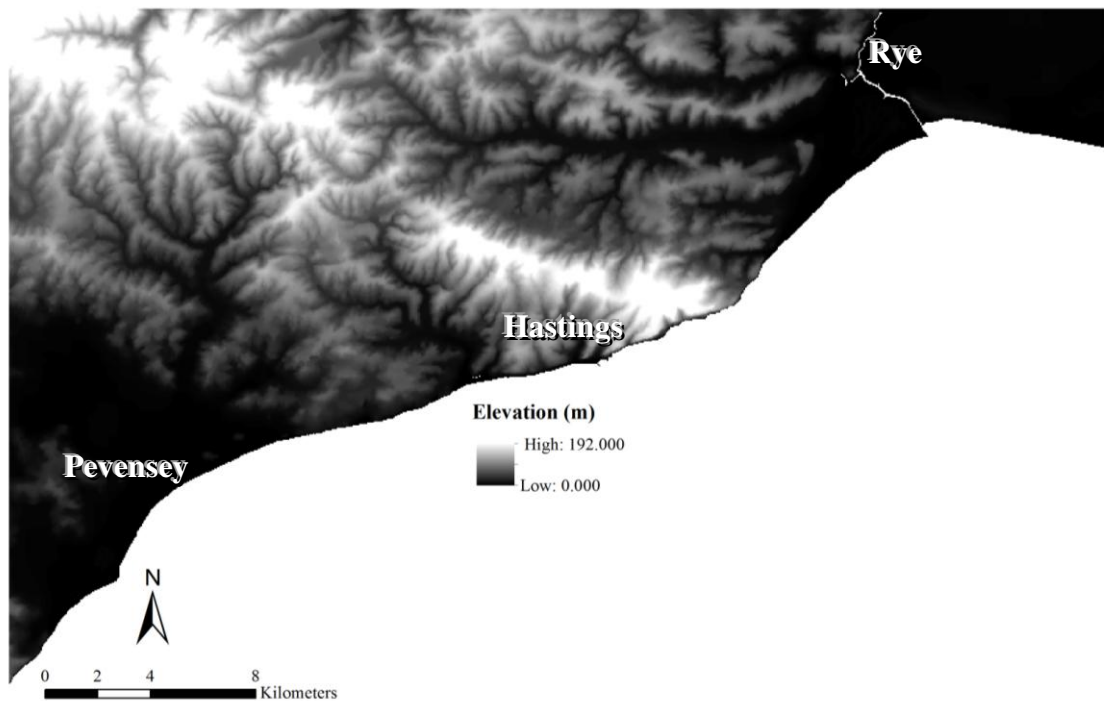
Following the examination of the land uses and climate undertaken in the previous sections, the chapter now focuses on a broader examination of landscape change since the

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<sup>31</sup> The *ASC* unfortunately does not mention weather in its description of the events (Swanton, 1998).

time of the battle. In order to undertake this analysis, this section presents the digital elevation models or DEMs required for use in the calculation of the RUSLE model.

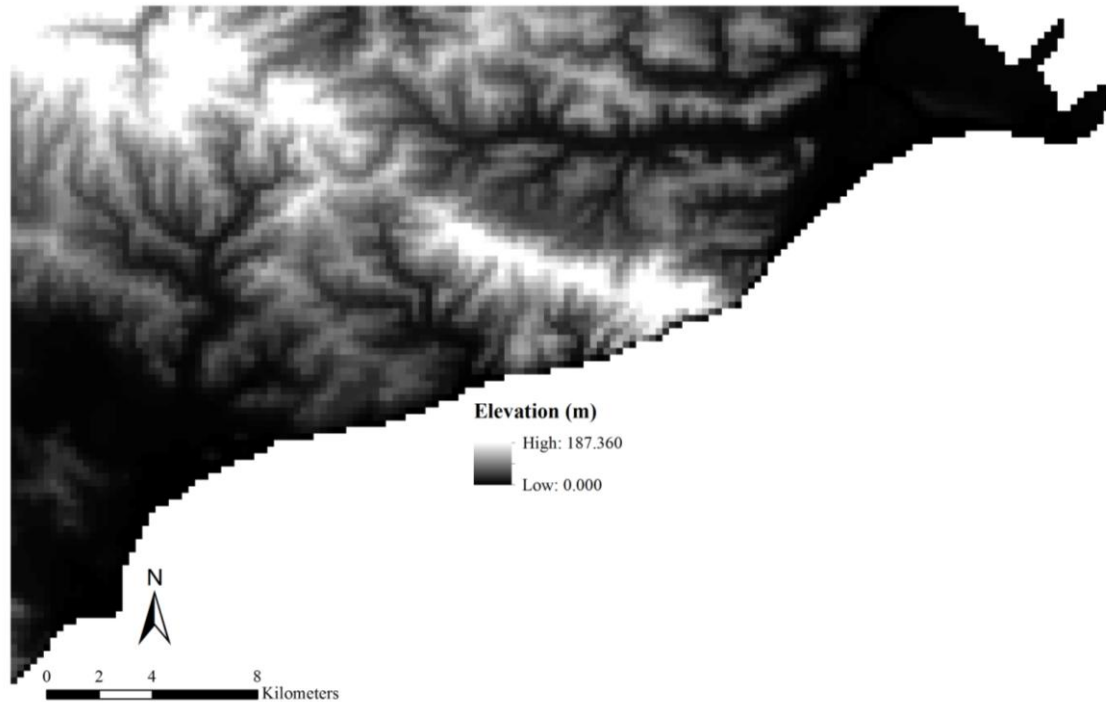
When calculating landscape change, it is necessary to ensure all the data is of the same resolution. For the 50 m resolution DEM from the Ordnance Survey (Figure 5.16), the average of 25 cells which would fit into a land use cell (250 m) was calculated and reported for that cell. The average was selected because it takes into account the full range of values. The new DEM is presented below in Figure 5.17.



**Figure 5.16: Hastings Area DEM at 50 m Resolution (2012)<sup>32</sup>**

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<sup>32</sup> DEM accessed from the OS (2012).



**Figure 5.17: Hastings Area DEM at 250 m Resolution (2012)<sup>33</sup>**

With respect to the Battle area DEM, the points represent the modern landscape which includes a prominent train line and roads (Figure 5.18). This evidence is accurate when examining the modern land uses, however for the historical ones, it is unnecessary. Therefore, the train line and the roads were edited out by removing all points within 55 m of the rail line and within 30 m of the roads.<sup>34</sup> Then the points were re-interpolated into a surface which would more closely approximate the historical one. The DEM was then smoothed to remove or minimize any calculation errors and minimize the existence of Battle Abbey (Figure 5.20).<sup>35</sup> The data was then averaged for both the modern and

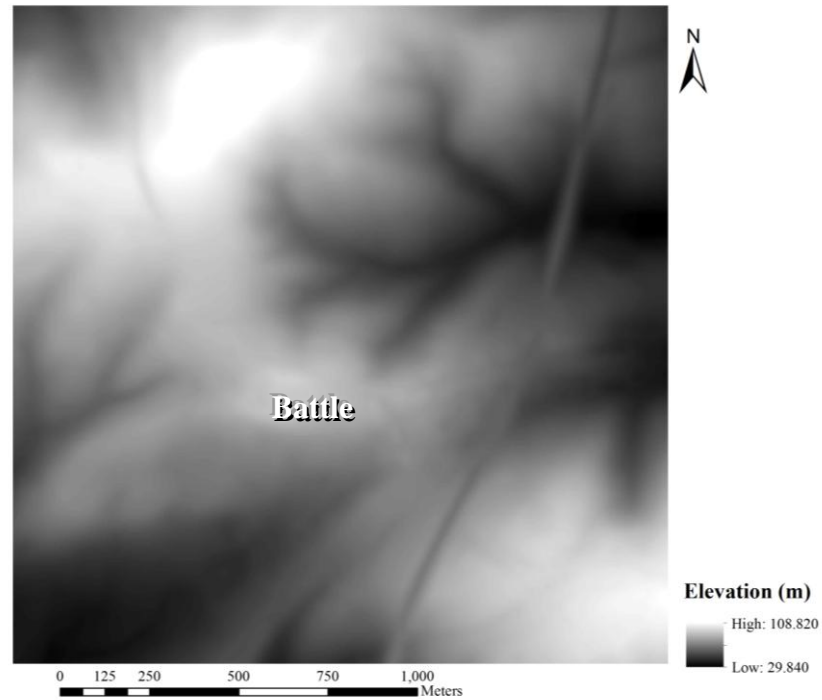
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<sup>33</sup> DEM accessed from the OS (2012) and then simplified.

<sup>34</sup> For a location of the local railway and roads see Figure 1.2.

<sup>35</sup> Based on the description of the buildings in the V.C.H. Sussex, ix, and the assumption that approximately 8 feet down of soil was dispersed during construction then the amount of material that would have been removed to build the buildings would have been about 17,000 m<sup>3</sup>. However, if that material was evenly spread out over the entire abbey precinct of 20 acres then the amount of topographical change would be 0.21 m. Therefore, the building of the abbey would not have made a large difference to the general shape of the terrain (pp. 102-5).

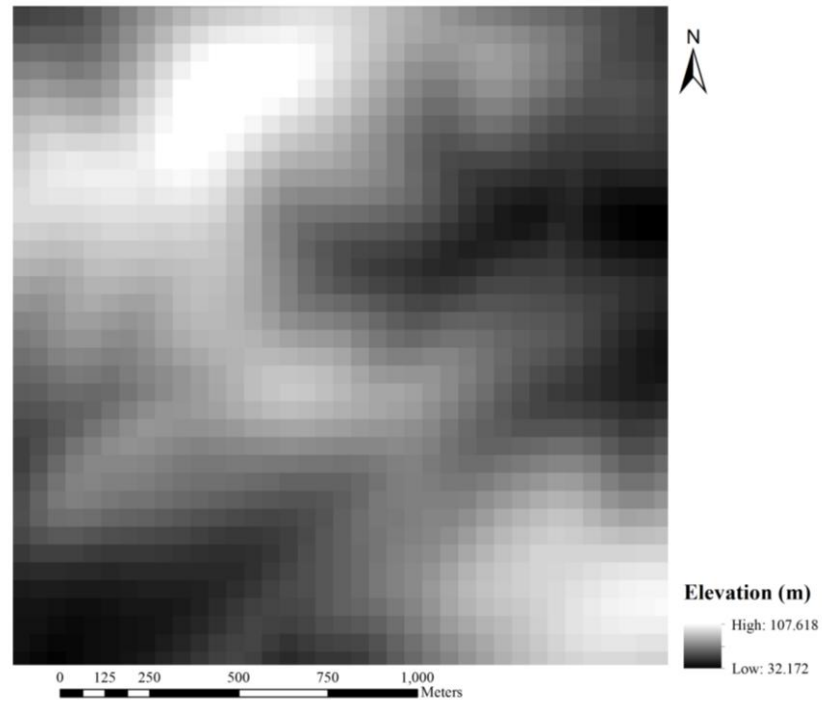
historical DEM's to the land use resolution of 50 m (Figures 5.19 and 21). With the DEMs thus refined as presented in the figures mentioned above, the chapter now moves to analysis of landscape change per se.



**Figure 5.18: 5 m Resolution DEM of the Battle Area with Rail Line and Roads Included (2009)<sup>36</sup>**

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<sup>36</sup> Data were accessed from Stanfords Business Mapping (2009).

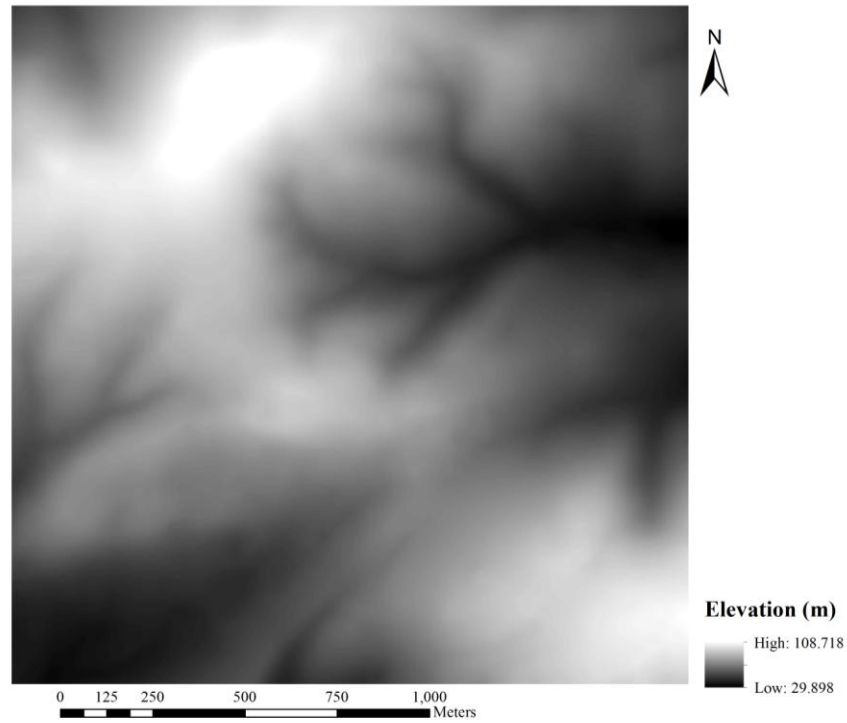


**Figure 5.19: 50 m Resolution DEM of the Battle Area with Rail Line and Roads Included (2009)<sup>37</sup>**

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<sup>37</sup> Data accessed from Stanfords Business Mapping (2009) and then simplified.

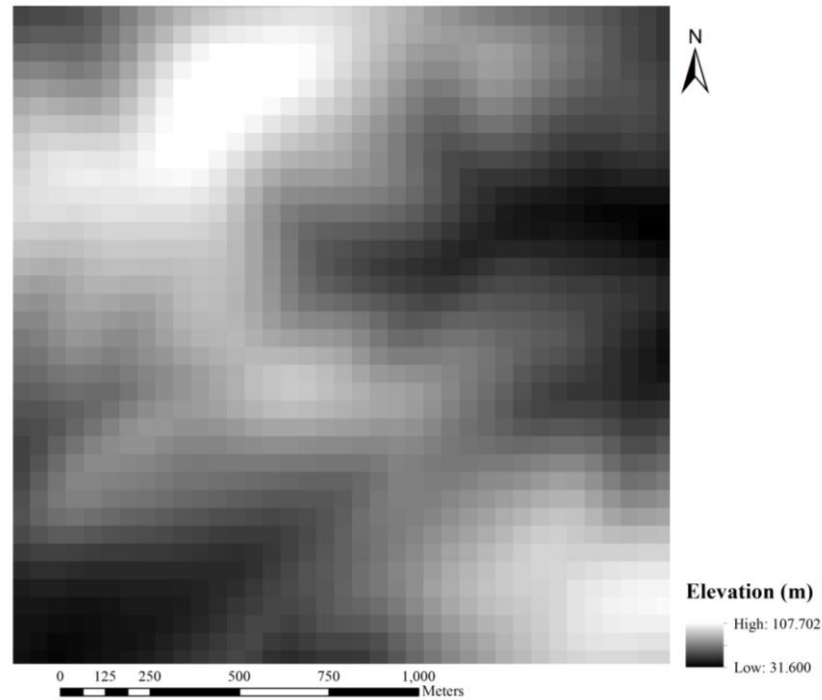




**Figure 5.20: 5 m Resolution DEM of the Battle Area without Rail Line and Roads Included (2009)<sup>38</sup>**

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<sup>38</sup> Data accessed from Stanfords Business Mapping (2009).



**Figure 5.21: 50 m Resolution DEM of the Battle Area without Rail Line and Roads Included (2009)<sup>39</sup>**

## 5.5 Landscape Change

This section combines the land use and climatic evidence analyzed previously to evaluate Hare's claim and thus the central element of research question 2 concerning landscape changes in the Hastings area since the time of the battle. As indicated in the introduction to this chapter, this analysis will be undertaken with the application of the revised universal soil loss equation (RUSLE) model. This model was discussed in detail in Chapter 3. Since, there is no measured landscape change data for the Battle area, the model will first be calculated for 250 m by 250 m plots over the entire Hastings area and then for the battle site at a resolution of 50 m by 50 m.

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<sup>39</sup> Data accessed from Stanfords Business Mapping (2009) and then simplified.

### 5.5.1 Landscape Change in Hastings Area

As stated above, the analysis opens with an examination of the entire Hastings area. Considering the average landscape decline over the past millennium, the RUSLE model will be tested with a variety of factors to ensure they are reliable for a localized study at Battle. The variables which contributed to the model include: precipitation (R), soil erodibility (K), topography (L and S) and land use (C and P). The R factor was calculated from the average annual precipitation data in Figure 5.14.<sup>40</sup> The K factor was determined from the literature as discussed in Chapter 2. The L and S factors were derived by several equations from a DEM. Initially, the slope was calculated from the DEM as both an angle and a percent. Next the L and S values were calculated based upon the equations in an erosion modeling handbook (Renard, Yoder, Lightle, & Dabney, 2011, p. 144).<sup>41</sup> The C and P values were assigned to the cells based upon the land use as defined above.

As previously discussed, the output of the model was in Mg / ha per year. This result was converted into landscape decline by multiplying the value by 1000 and then dividing it by 10000 to obtain kg / m<sup>2</sup>. This finding can be converted into landscape decline in meters by dividing it by the density in kg / m<sup>3</sup>.<sup>42</sup> However, since the project progressively moves back in time, the sediment was then added to the landscape. Conversely, when the model was moving forward in time, the sediment was subtracted from the landscape.

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<sup>40</sup> The equation to transform the precipitation value (mm) into the R value depends on the amount of rain fall. For less than 850 mm use the equation:  $R = 0.04830P^{1.610}$  and for above 850 mm use:  $R = 587.8 - 1.219P + 0.004105P^2$  with  $P$  representing the total amount of precipitation (mm) (Renard & Freimund, 1994, p. 299).

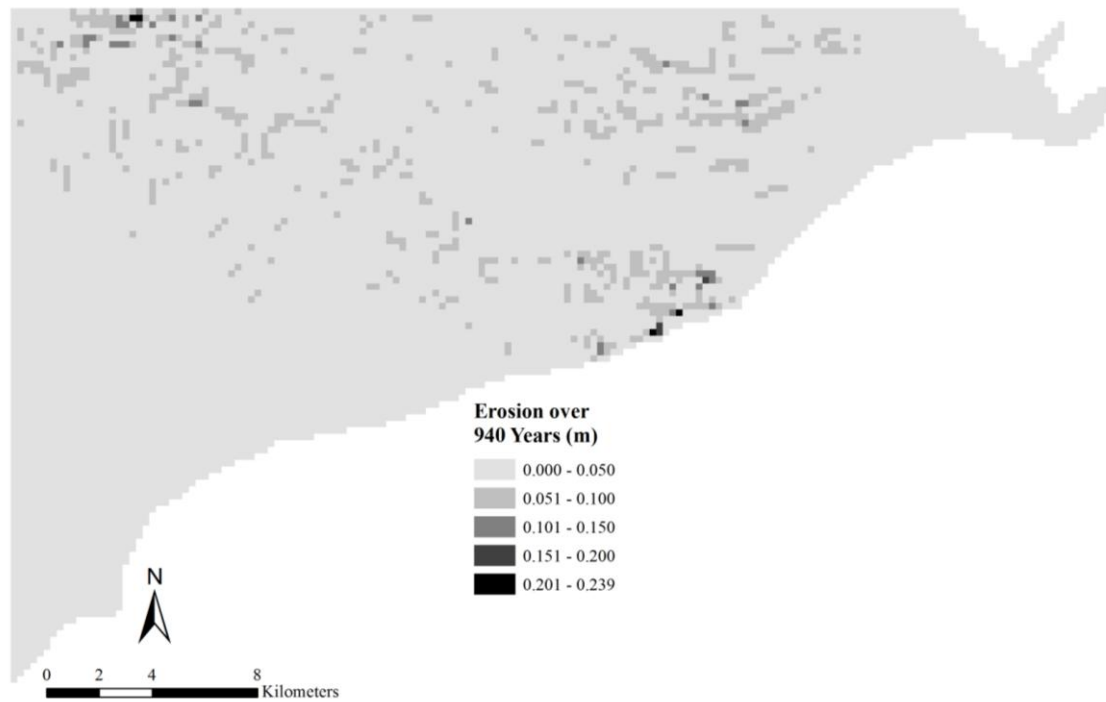
<sup>41</sup> For the L factor, first the  $\beta$  is calculated as:  $\beta = (\sin \theta / 0.0896) / [3.0(\sin \theta)^{0.8} + 0.56]$  with  $\theta$  representing the slope angle. Next  $m$  is calculated as  $m = \beta / (1 + \beta)$ . Finally the L factor is calculated as  $L = (\lambda / 22.128)^m$  with  $\lambda$  representing the actual length of the plot (250 m) (Renard, Yoder, Lightle, & Dabney, 2011, p. 144). For the S factor, the equation depends upon the slope percent. Where  $S < 9\%$  use  $S = 10.8 \sin \theta + 0.03$  and where  $S > 9\%$  use  $S = 16.8 \sin \theta - 0.50$  (Renard, Yoder, Lightle, & Dabney, 2011, p. 144; McCool, Foster, & Weesies, 1997, p. 107).

<sup>42</sup>  $\frac{kg}{m^2} / \frac{kg}{m^3} = \frac{kg}{m^2} * \frac{m^3}{kg} = m$

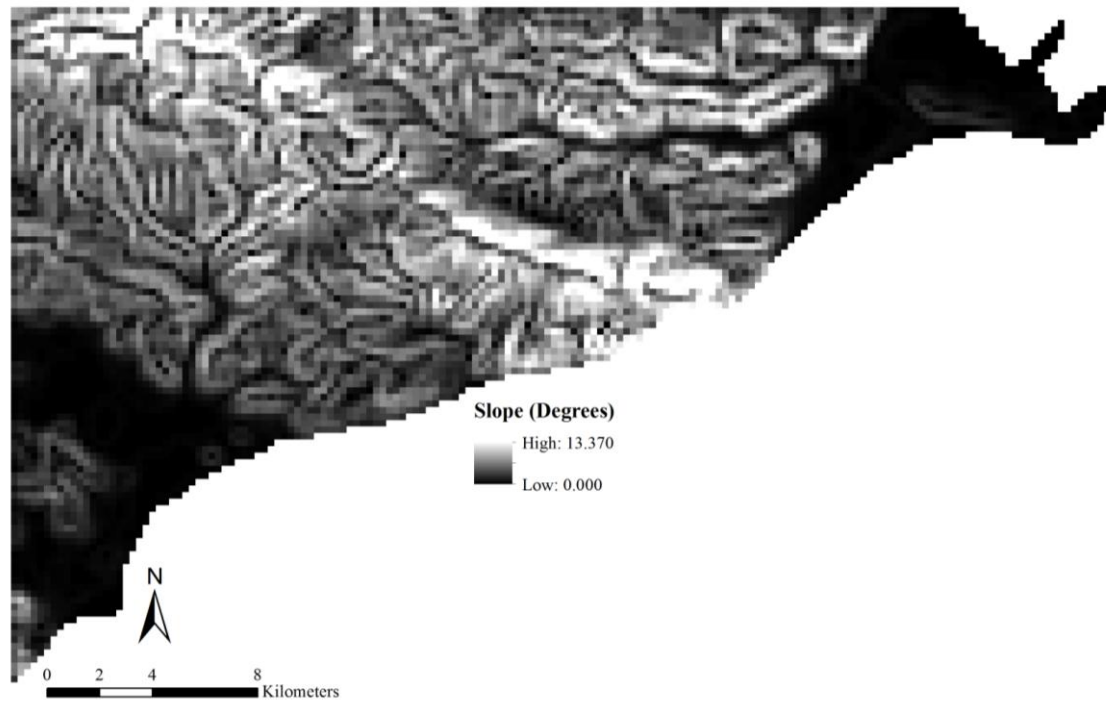
The model was tested with several methods. The first was to step the landscape back to 1065 by 50 year intervals. This procedure means that every 50 years, a new DEM was generated and the L and S factors were recalculated. Once back to 1065, the model was then run forward directly in time to 2005. This test produced fairly similar results to the original DEM. However, in order to confirm that the two DEM's were indeed the same, the difference between the two was calculated. Table 5.7 lists the summary statistics which indicate that the majority of the differences between the DEM's were less than 0.001 m. Therefore, the modeled DEM is an accurate prediction for the 2005 landscape. This argument also implies that since the modeled 2005 landscape is based upon the 1065 landscape then the estimated 1065 landscape is accurate.

**Table 5.7: Summary Statistics for Differences between Models: Uniform Fieldscapes in Hastings Area**

<b>Statistic</b>	<b>Between 2005 DEMs</b>	<b>Between 1065 DEMs</b>	<b>Erosion over 940 Years</b>
Minimum (m):	-0.000	-0.000	0.000
Maximum (m):	0.000	0.001	0.239
Sum (m):	0.039	-0.017	138.628
Mean (m):	0.000	-0.000	0.016
Standard Deviation (m):	0.000	0.000	0.021



**Figure 5.22: Landscape Change (2005 – 1065) in the Hastings Area at 250 m Resolution**



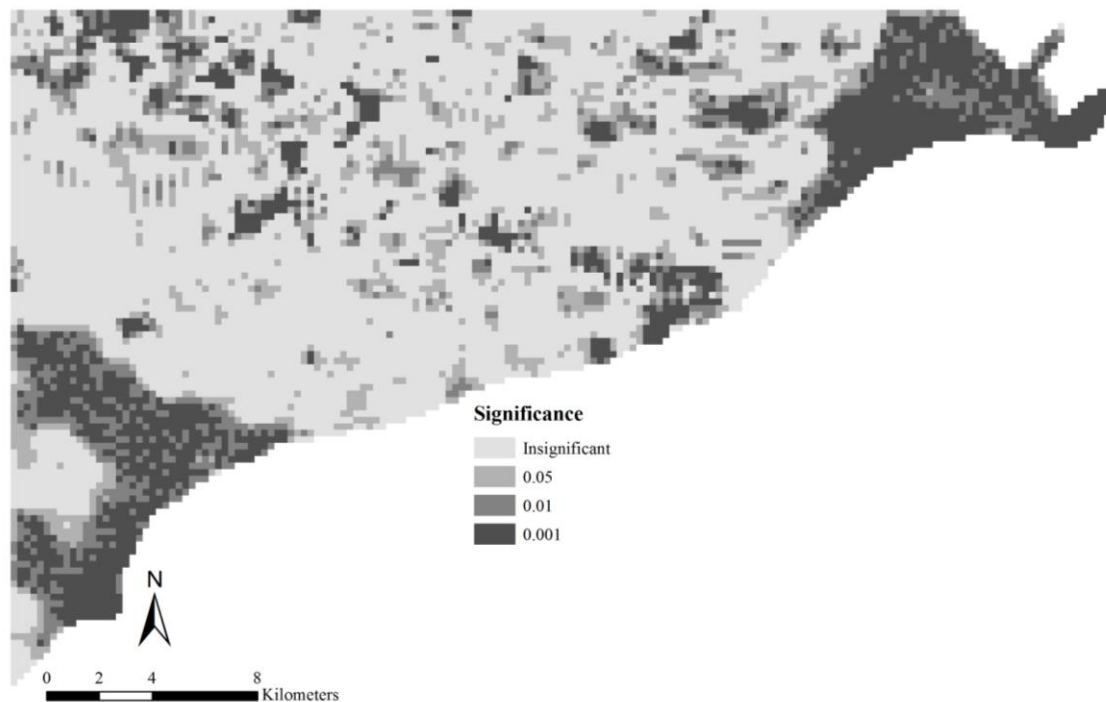
**Figure 5.23: Hastings Area Slope (2012) in Degrees at 250 m Resolution<sup>43</sup>**

The second column of Table 5.7 compares two DEMs which represent 1065. One presents the direct model from 2005 to 1065 while the other represents the stepped back model over the same period. They indicate a difference of less than one cm which indicates a high degree of accuracy. The final column in Table 5.7 details the amount of erosion since the battle until 2005. These data are represented cartographically in Figure 5.22. This figure indicates that the landscape has declined by less than 30 cm and more likely closer to the mean of 1.6 cm over the past 940 years. Compared with the slope map (Figure 5.23), the cells with higher erosion rates are in areas with steeper slopes. These results can be further assessed statistically with a LISA test for spatial autocorrelation (Chapter 3). The results from this analysis indicate that after 999 permutations, the Moran's  $I$  is statistically significant at 0.418 with a probability ( $p$ ) value of 0.001. Since this value is  $> 0.3$ , there is spatial clustering. A LISA test can also be visualized with maps. The figures below indicate the spatial significance (Figure

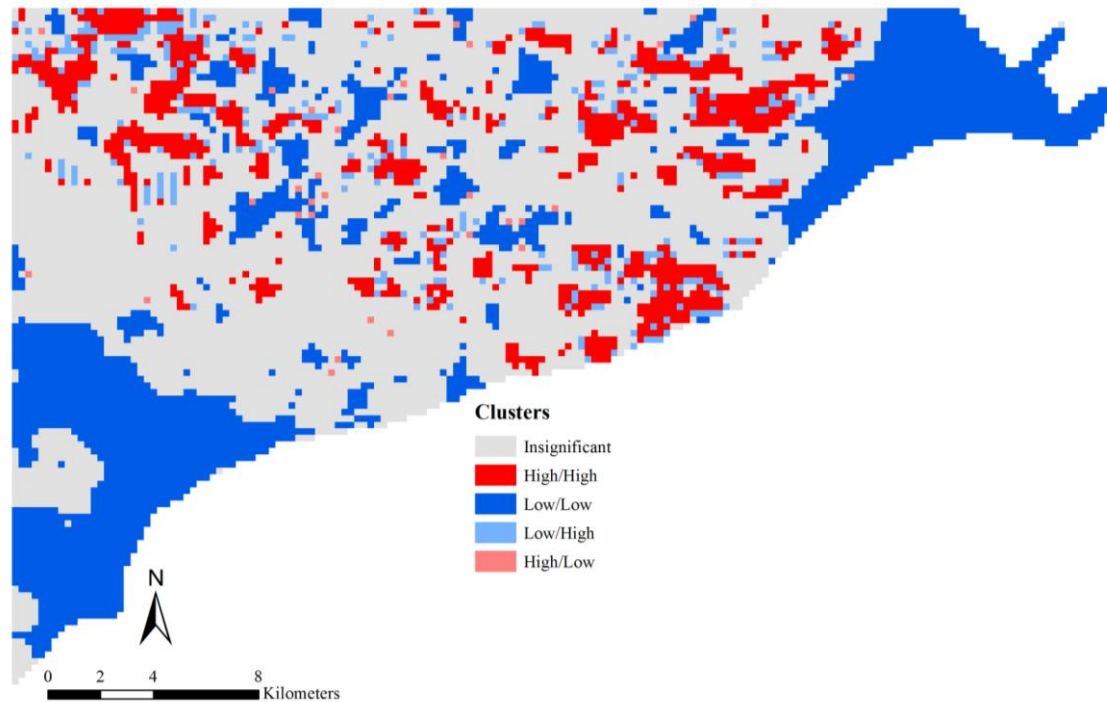
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<sup>43</sup> Slopes derived from DEM accessed on the OS website (2012).

5.24) and clustering (Figure 5.25) of the results. When compared to the land use and topography, the low/low areas are in the low lying areas which were once marshland but are now fieldscapes. Conversely, the high/high areas are located in the areas with higher elevation. These maps can also be compared to the local slopes (Figure 5.23) which suggest the large low/low areas in Pevensey and Rye are flat while a number of the high/high areas are in steeper regions. Therefore, the amount of change is spatially dependent with respect to topography.



**Figure 5.24: Significance Map of Landscape Change (2005 – 1065) in the Hastings Area at 250 m Resolution**



**Figure 5.25: Cluster Map of Landscape Change (2005 – 1065) in the Hastings Area at 250 m Resolution**

Table 5.8 lists several reliability tests which were conducted on the results of the data. The first was to set the P value to a constant of 0.1, so as to control its effect, given the issues of reliability as discussed in detail in Section 5.2. Another variable which is examined is rainfall. In columns two and three, the rainfall was increased and then decreased respectively by ten percent. These results provide a range of sediment yields as well as reflect the uncertainty in the precipitation data. The final two columns present the variation in the density of the material with a minimum of  $0.9 \text{ Mg/m}^3$  and a maximum of  $1.5 \text{ Mg/m}^3$  (Brady & Weil, 2004, p. 106).



**Table 5.8: Summary of Reliability Tests for Uniform Fieldscales in Hastings Area**

<b>Statistic</b>	<b>Set P Value</b>	<b>10% Less Rain</b>	<b>10% More Rain</b>	<b>Minimum Density</b>	<b>Maximum Density</b>
Minimum (m):	0.000	0.000	0.000	0.000	0.000
Maximum (m):	0.186	0.202	0.280	0.345	0.207
Sum (m):	112.095	117.004	162.217	200.241	120.144
Mean (m):	0.013	0.014	0.019	0.023	0.014
Standard Deviation (m):	0.016	0.018	0.024	0.030	0.018

Table 5.9 contains statistics for the same model except the fieldscape land use has been differentiated into cropland or pasture based upon the sub characterizations in the ESHER database and the terms in the interpretation (Bannister, SHLC - V, 2010, pp. 36-38; ESHER, 2013). Hence, for some areas (i.e. cropland) there was more erosion than for others (i.e. pasture or woodland). As to which fields were cropland or pasture and for how often over history is a detailed study unto itself and thus beyond the scope of this research. Therefore, these results are presented simply to indicate the ranges which could exist.

In terms of interpretation, the first column of Table 5.9 represents the amount of erosion over the study period. The subsequent columns are the same as those presented in Table 5.8. Again, these values tend to indicate that the change in variables does not appear to influence the general trend of the model. Therefore, this model has a measure of reliability.

As a measure of overall model validity, the combined results from both Tables 5.8 and 5.9 were compared using the model efficiency coefficient with the reported measured values.<sup>44</sup> The result from this test was 0.250 which is less than the desired value of 0.500. However, this value was calculated based upon the few results reported by Williams & Robinson and not on a dataset of recorded values (1983, p. 47). In the final analysis, the fact that the results were relatively close to 0.5 indicates that the model is reliable and valid. Thus, the model can be applied to the Battle area, as is undertaken in the next section.

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<sup>44</sup>  $CE = \frac{\sum(X_{obs}-x_{mean})^2 - \sum(x_{pred}-x_{obs})^2}{\sum(X_{obs}-x_{mean})^2}$  (Morgan, 2005, pp. 148-9).

**Table 5.9: Summary of Reliability Tests for Differentiated Fieldsapes in Hastings Area**

<b>Statistic</b>	<b>Erosion over 940 Years</b>	<b>Set P Value</b>	<b>10% Less Rain</b>	<b>10% More Rain</b>	<b>Minimum Density</b>	<b>Maximum Density</b>
Minimum (m):	0.000	0.000	0.000	0.000	0.000	0.000
Maximum (m):	0.882	0.355	0.716	0.991	1.278	0.767
Sum (m):	279.712	125.476	226.675	313.807	403.787	242.272
Mean (m):	0.032	0.014	0.026	0.035	0.046	0.027
Standard Deviation (m):	0.061	0.025	0.049	0.068	0.088	0.053

### 5.5.2 Landscape Change in Battle Area

The variables in the Battle model are the same as in the Hastings area model as undertaken above except that when the land uses were converted into a raster format, some cells contained missing values due to deficiencies in the ESHER. This error was corrected by applying a filter over the data layers which filled in the missing data. The filter was a 3 by 3 “moving window” function which smoothed out the surface (Bolstad, 2005, p. 364). This data correction provides more robust results insofar as missing data are marked with a value based upon the surrounding data, thus ensuring reliability.

The RUSLE analysis for the Battle area is presented below in Tables 5.10 and 5.11. Based upon the method utilized in Table 5.7, the Hastings area model was calculated both directly and stepping back in 50 year increments, producing very similar results. Therefore, it was decided to simply run the Battle area model directly back to 1065.

**Table 5.10: Summary of Reliability Statistics for Uniform Fieldsapes in Battle Area**

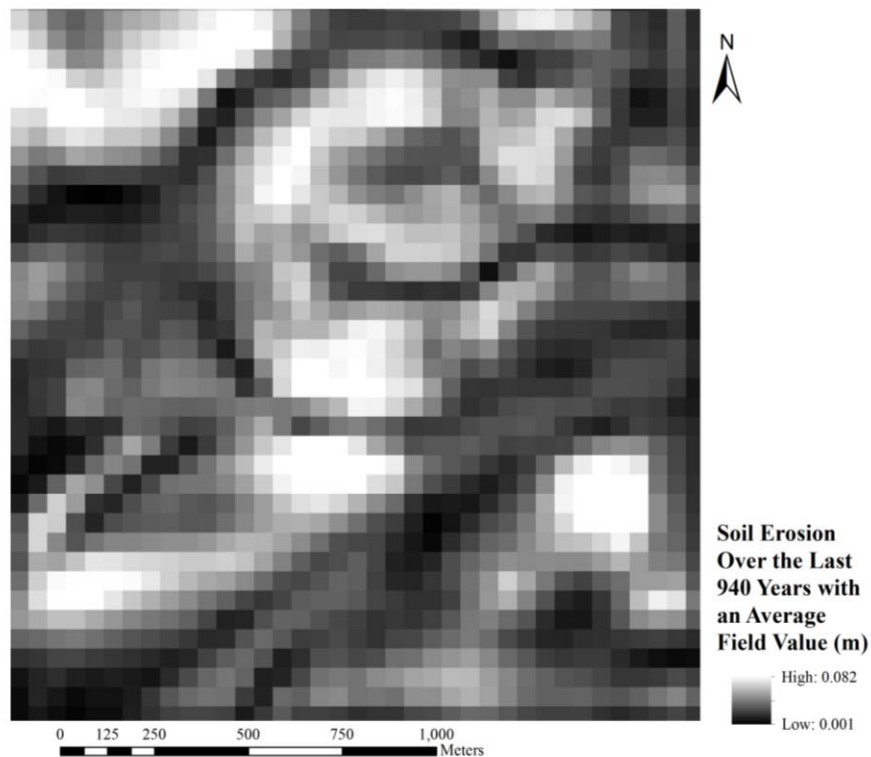
<b>Statistic</b>	<b>Erosion over 940 Years</b>	<b>Set P Value</b>	<b>10% Less Rain</b>	<b>10% More Rain</b>	<b>Minimum Density</b>	<b>Maximum Density</b>
Minimum (m):	0.001	0.001	0.001	0.001	0.001	0.001
Maximum (m):	0.082	0.066	0.069	0.095	0.118	0.070
Sum (m):	46.178	40.686	38.974	54.031	66.702	40.021
Mean (m):	0.028	0.025	0.024	0.033	0.041	0.024
Standard Deviation (m):	0.016	0.013	0.014	0.019	0.023	0.014

Table 5.10 presents the summary statistics for the RUSLE model on the Battle area. These figures indicate that the change in topography over the last 940 years has been on average around less than 5 cm and the maximum between all the models has been 11 cm. As with Tables 5.7 to 5.9, the results are similar which indicates the model is reliable. The results are cartographically displayed in Figure 5.26. Compared to the local slopes (Figure 5.27), again the higher erosion rates match the areas with steeper slopes. In these models all the fields were classified as one land use. Therefore, as above, in order to consider the results if the land was more often utilized for cropland or pasture, a second model was run with the fieldscape land uses broken down into either cropland or pasture. These findings are presented below in Table 5.11.

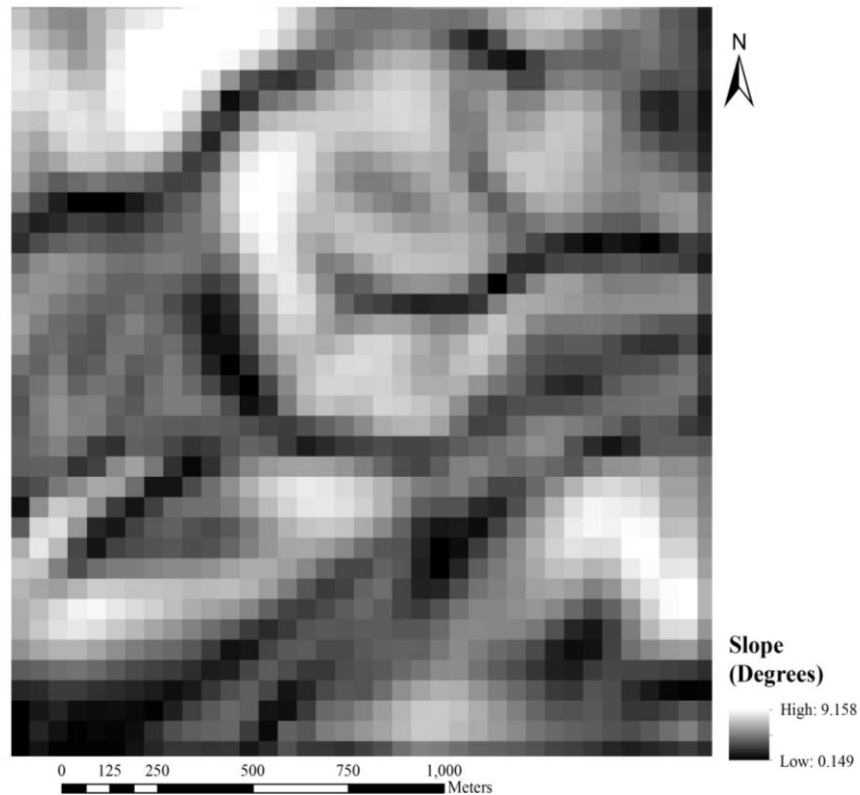
**Table 5.11: Summary of Reliability Statistics for Differentiated Fieldscales in Battle Area**

<b>Statistic</b>	<b>Erosion over 940 Years</b>	<b>Set P Value</b>	<b>10% Less Rain</b>	<b>10% More Rain</b>	<b>Minimum Density</b>	<b>Maximum Density</b>
Minimum (m):	0.000	0.000	0.000	0.000	0.000	0.000
Maximum (m):	0.299	0.120	0.252	0.348	0.431	0.259
Sum (m):	87.138	48.179	73.545	101.961	125.866	75.519
Mean (m):	0.053	0.029	0.045	0.062	0.077	0.046
Standard Deviation (m):	0.063	0.026	0.053	0.074	0.092	0.055

Table 5.11 indicates there would be more erosion than is suggested in Table 5.10. Specifically, the largest amount of potential erosion is approximately 43 cm or four times more. However, this value would be assuming a cropland land use for every year between 1065 and 2005. Therefore, the actual values for the erosion rates would tend to be somewhere in between the ranges presented above. Again, as indicated above, the model's results are consistent, which suggests the reliability of the model. At the same time, the model's validity cannot be assessed as there is no literature which would suggest the amount of erosion for the Battle area specifically. In addition the results are also consistent with Williams & Robinson for the Hastings area (1983).



**Figure 5.26: Landscape Change (2005 – 1065) in the Battle Area at 50 m Resolution**



**Figure 5.27: Battle Area Slope (2009) in Degrees at 50 m Resolution<sup>45</sup>**

In summary, as the figures developed in this section show, in the absence of major hillslope processes (Williams & Robinson, 1983, p. 35), the rates of local topographic change tend to be on the order of millimeters per year (Trenhaile, 2010, p. 142). The total amount of soil removed has been roughly between 4 to 15 centimeters over a millennium (Williams & Robinson, 1983, p. 47). Thus, very little has been altered by physical processes on this landscape since the battle. This finding is in substantial contradiction with the propositions by Hare and Lawson who had suggested much more substantial landscape changes in the period between 1065 and the present.

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<sup>45</sup> Slopes derived from data provided by Stanfords Business Mapping (2009).

## 5.6 Sources of Error with Landscape Change

From Figure 5.22 and Figure 5.26, there is a clear spatial variation in the amount of sediment eroded since the battle. This variation could be the result of errors in the model. These could include errors in the land use classification, since a comprehensive analysis on all documents regarding land use was not conducted. Therefore, some areas could potentially have been labeled incorrectly. This error could impact the erosion rate at a specific location to be more or less than it should be. Another potential source of error linked to land use is the P value, which stems from the fact that there were no estimations for this value in non-agricultural settings.<sup>46</sup> This error was corrected for by estimating the values from the proportion per land use between the C values. The model was also run with a set P value to see if there was a large difference between the two. Another potential source of error came from the fact that there were few if any studies to compare with the results of this study. This lack of similar studies is problematic specifically in the urban areas which become rather extensive in the twentieth century. Nonetheless, as indicated above, local studies do agree with the general amount of soil loss. Therefore, there is an element of reliability to the model.

A second source of error derives from the DEMs as they were simplifications of the original data. In this model the average between the input cells was selected because it would consider all of the input data unlike the other statistics such as the minimum and maximum which only consider one value. Furthermore, it is likely the minimum and maximum would have produced similar results. Therefore, the ideal simplification method would have been the average value.

The final source of error to be discussed is the relationship between the local measured precipitation and the reconstructed precipitation. As indicated above the correlation between the two was low at around 0.354. This fact could imply that the precipitation values may not be accurate for the area. Therefore, to correct for this uncertainty, the

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<sup>46</sup> Non-agricultural values for the C and P values would make for a worthwhile study which is beyond the scope of this project.

model was run with ten percent more and less rainfall in order to see the range of values produced. Thus, in conjunction with other uncertainties such as soil density, a range of landscape decline values is provided. These statistics indicate that the physical landscape processes have not greatly impacted the landscape since the Battle of Hastings.

## 5.7 Conclusion

This chapter addressed research question 2 concerning the land use, climate and topographical changes in the Hastings area since the battle. As part of this investigation, the chapter opened with a review of the typical landscape processes influencing the Hastings area. Then as a preparatory analysis for the RUSLE model the land uses were regressed from the present to 1066. This section also included a table compiled with land use definitions and erosion factors. The subsequent section examined the precipitation changes in the Hastings area since the battle as well as written descriptions of the weather during the 1066 campaign. Following this discussion the DEMs were investigated and simplified where required for the analysis. In the final section, the RUSLE model was calculated from 2005 to 1065 for the respective Hastings and Battle areas.

Overall, it was revealed through a comprehensive analysis of the cartographic and environmental sources by map regression and the RUSLE model that the claims reported by Hare and promoted by Lawson are incorrect. The general shape and slope of the battlefield has remained the same since the battle. This knowledge is important going forward because it indicates the modern topography can be easily modified to depict the topography of 1066. This finding is particularly relevant to the subsequent chapters on the local resources and the battle itself is the topography of 1066.

In the following chapter, the resources available to the English and Norman armies at the time of the Battle of Hastings will be investigated.



## Chapter 6

### 6 Available Resources in the Hastings Area

Armies are people; they live in an environment, and they require food, tools and water. Nonetheless, in the literature on the Battle of Hastings, such resources are only briefly mentioned if at all (Lawson, 2003, pp. 180-1; Morillo, 1994, pp. 126-7). The exception to this trend is Bachrach's article (1985) on the military administration of the 1066 campaign. This article examines the Norman camp at Dives in Normandy and the challenges of supplying the army. Even at that, other historians have questioned some of the findings, particularly concerning the size of the horses used in the battle and the amount of feed that was required (Davis, 1987, p. 80).

In this chapter, through documentary, cartographic and environmental sources, interpreted through GIS-based interpolations and table-based analyses, research question 3, "*what resources (e.g. animals, food, industry, and water) were available to the English and Norman armies,*" will be explored. Specifically, following an examination of the local land uses and their relevance to resource availability, the discussion will focus on the armies' local access to food, water, and industrially produced implements. Obviously, resources such as these would have been critical to sustaining the two armies in an extended campaign.

#### 6.1 Land Uses in 1066

In its natural state, the Hastings area could be described as "typical undulating wealden country, dense woods, predominantly oak, and great open stretches of grass-land diversified by clumps of trees" (V. C. H. *Sussex* IX, p. 126). It is into this landscape that Harold and William would have arrived in 1066.

In this section, the local land uses in which the Battle of Hastings was fought, and the associated implications of these for resource availability will be investigated. This discussion will be split into a general examination of the entire Hastings area followed by

the Battle area. The section will end with a description of potential sources of error. The findings in this section are further utilized in the analysis of the battle in Chapter 7.

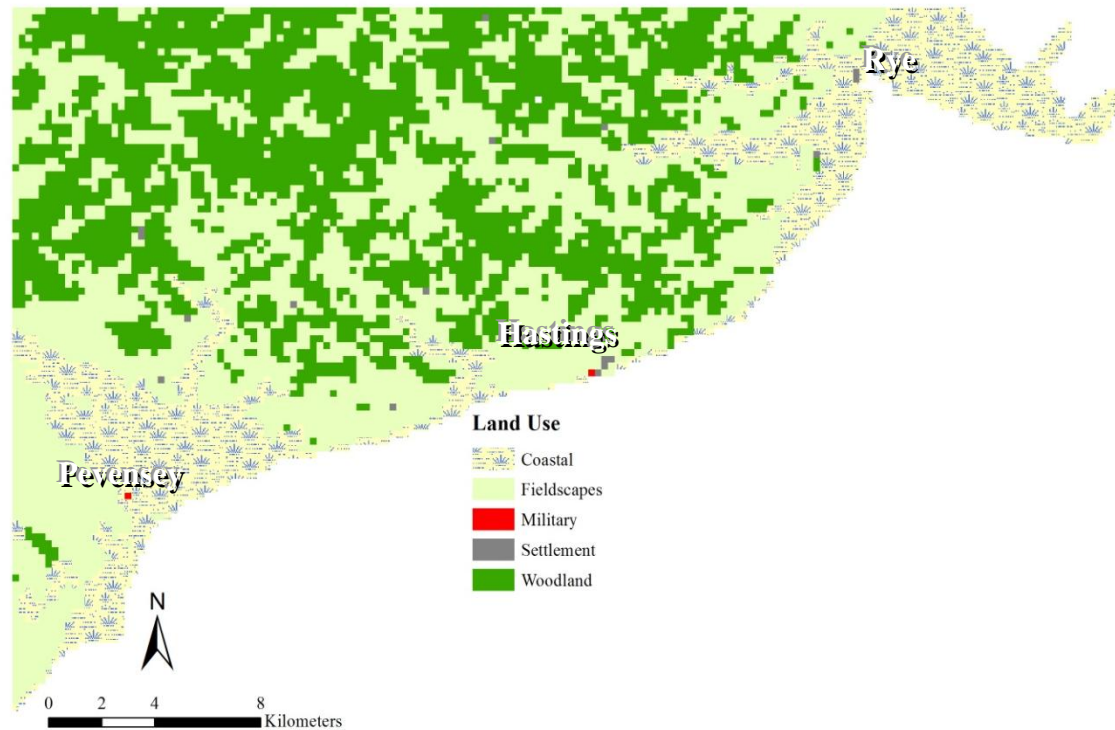
### 6.1.1 Hastings Area Land Uses in 1066

Determining even a rough estimate of the land uses for a location in the distant past at a specific date in time is fraught with numerous potential errors. By carefully examining later land uses and errors associated with them, a workable land use map was generated for this study (Harvey, 1985). To ensure continuity with the rest of the study, this map, as presented in Figure 6.1, was produced at the same resolution as the figures in Chapter 5. It also possesses similar classifications such as those presented in Table 5.1.

As indicated previously in Chapter 5, it can be generally assumed that approximately 80 percent of the 1086 acreage was still considered arable land in 1914 (Cantor, 1982, p. 17).<sup>1</sup> This knowledge provides us with a starting point from which the medieval land use can be deduced. This however, represents only an approximation, as the actual ratio of arable land from 1086 to 1914 would have varied throughout the region with the value lower in the wooded area north of Battle, known as the Weald.

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<sup>1</sup> It was also indicated that this value varied throughout England for example; the proportions of arable were higher in the Sussex plains but lower in the Weald (Cantor, 1982, p. 17).



**Figure 6.1: Estimated Hastings Area Land Use in c. 1066<sup>2</sup>**

The land uses presented in Figure 6.1 consist of coastal, fieldscapes (crop land), and woodland. The coastal land use would have consisted of beaches and extensive marshes or tidal flats. It has been estimated that both the Pevensey and Rye areas were extensive marshlands with river channels throughout (see Appendix A). There would likely have been many marsh plants and animals in these areas as well. Thus, from a resource perspective, the marshes in the area would have been ideal sites to provide a reliable source of food, such as fish and water fowl, for an army over an extended period of time.<sup>3</sup>

In terms of crop land, there are three estimates that can be deduced from a selection of *DB* sites as depicted in Figure 6.3. The oldest is by Seebohm, who related the arable acreage to the number of recorded villagers per manor (1883, pp. 102-3). Seebohm's

<sup>2</sup> This map is primarily derived from the ESHER (2013).

<sup>3</sup> A book entitled *Wetland Ecosystems* provides details on the extensive list of plants, animals and birds William's men would have located in the marshes (Mitsch, Gosselink, Anderson, & Zhang, 2009).

method was calculated using the values presented by Campbell and assumes that each villager had 22.5 acres, each bordar, cottager, and smallholder had 3 acres and the manor had 120 acres of demesne land on average (2000, p. 389; Seebohm, 1883, pp. 101-2).<sup>4</sup> This calculation produced a value of 27468 acres. Other methods utilized by Lennard and Maitland produced estimates based upon the number of plough-teams (100 acres) and lands (120 acres) per manor (Lennard, 1959, p. 393; Maitland, 1987, p. 435). As the study area included 374.5 plough-lands or 474.875 plough-teams then the rough extent of arable was between 44940 and 47487.5 acres (Campbell, 2000, pp. 386-7; Darby, 1977, pp. 129-31). Based upon Figure 6.1 this study, by contrast, estimates the size of the arable land much higher, at just under 58000 acres.<sup>5</sup> Considering the difference in values from the *DB*, this estimate is however highly speculative. Not all of the fieldscapes would have been agricultural, pastoral or left to fallow (i.e. natural unused grassland with some trees) and thus the reported figure can only approximate the values from the *DB*. Regardless of the estimate used, however, the amount of arable land was probably considerable. It is highly likely, moreover that this cropland would have been made available to the two armies during their stay in the Hastings area.

In terms of woodland, the largest change between the 1499 – 1066 land use presented in Figure 5.11 and that of 1066 would have been in the extent of coverage of woodland as a result of deforestation. According to the authors of the V.C.H., the woodland would have stretched along a piece of land known as the “Forest Ridge” from northeast of Hastings to the far side of the county. Several existing forests are considered the last vestiges of the original forest (V.C.H. *Sussex* I, pp. 49-50).

For Figure 6.1, a number of techniques were used to estimate the extent of woodland in this period. One method was to examine the areas labeled as parks. These areas were

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<sup>4</sup> The population consisted of 700 villagers, 14 bordars, 157 cottagers, 95 smallholders, 3 slaves, and 202 burgesses (Palmer, 2010; King, 1962, p. 438). The total recorded population for the area would be 1171 people.

<sup>5</sup> There were several *DB* sites just beyond the border of the map which were not considered in the analysis. These areas would partly contribute to the 58000 acres as well.

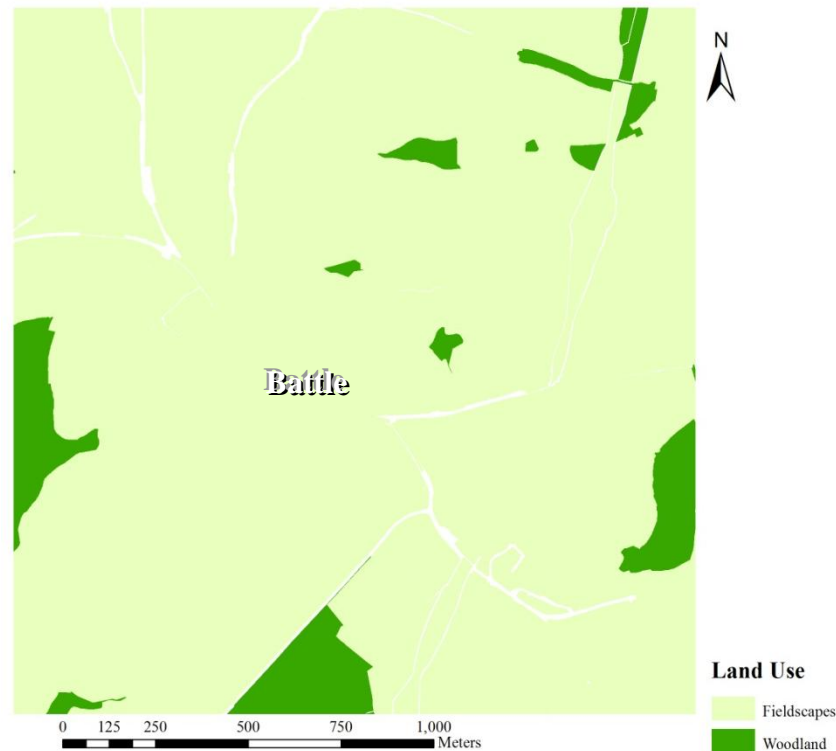
classified as designed landscapes in the ESHER although a review of the entries in the V. C. H. *Sussex* I and XI was required before labeling them woodland. An additional method of classifying woodland was through ESHER areas classified as assarts (2013). The term assart is Middle English, and means forest cleared for agriculture (Field, 1972, p. 267). Approximately 86 percent of the areas listed as assarts in the ESHER database were dated to the medieval period (1066 to 1499) with none dated before 1066.<sup>6</sup> Therefore, they were begun after 1066. Thus, by including areas designated as assart, in addition to the areas already classified as woodland, we can get a sense from Figure 6.1 of how extensive the woodland might have been when William arrived in the Hastings area. It is also reasonable to assume that both armies would have made use of this resource in terms of building materials and weapons production.

### 6.1.2 Battle Area Land Uses in 1066

Much has been written about Battle Abbey in the medieval period. The most eminent scholar was Eleanor Searle who not only discussed the Battle community (1974) but also provided a complete translation of the *Chronicle of Battle Abbey* (1980) (Chapter 2). With respect to land use, Searle characterized the Battle environment as without “strips because there were no common fields. There was only the vill, and beyond it the leuga, divided into the wists characteristic of the weald: single arable farmsteads enclosed by the forest” (1974, p. 82).

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<sup>6</sup> A discussion of woodland clearances in the Weald is presented by Brandon (1969).



**Figure 6.2: Estimated Battle Area Land Use in c. 1066<sup>7</sup>**

Overall, the land uses in the Battle area, as reproduced in Figure 6.2, consisted of woodland, and fieldscapes. The woodland tended to be on the marginal sections of the landscape such as the small valleys or on the steeper slopes (Baker, 1973, pp. 423-4). The remainder of the landscape was fieldscapes. One historian has indicated that the original hill would have been covered in local grasses (Bradbury, 1998, p. 142). This finding is consistent with claims by a battlefield archaeologist who indicated that battles in the medieval world and before occurred in open fields with few if any impediments to the conflict (Carman & Carman, 2006, p. 21). In all probability then, this reconstruction was the landscape that Harold and William would have seen when they arrived in 1066.

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<sup>7</sup> This map is derived from the ESHER (2013).

Figure 6.2 also provides for the first time in this study, a map of the battlefield to be examined in more detail in Chapter 7.

## 6.2 Population

Populations also provide armies with critical resources. Such resources are typically linked to local ways of life. The following sections will explore the daily life of the Hastings population and the population distribution by village in the area.

### 6.2.1 Daily Life and Employment

The population at Hastings is described in detail in the *BA*. However, this source originates from the early twelfth century and there had been increased immigration to the area since 1086 (Searle, 1974, p. 70). Therefore, the population is not necessarily reflective of the population in 1066, although, there are some general characteristics that can be inferred from the record. Local trade jobs such as bakers, brewers, carpenters, farmers and various labourers were probably present in many of the local villages at the time (Bennett & Hollister, 2006, p. 161). Another source which is particularly useful for daily life and employment at the village level is the *Rectitudines Singularum Personarum* (*RSP*). This document describes the various positions in the village and what they were responsible for (Harvey, 1993). The positions of interest in this list include the *ge.neat*<sup>8</sup> and *thegn*<sup>9</sup> (*EHD* II, p. 875-8).<sup>10</sup>

Based upon evidence contained in the *RSP* as discussed in Chapter 2, some of the positions might have had defense implications, such as the *thegn* who was expected to fight (*EHD* II, p. 875). This evidence in turn provides some limited insight into who

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<sup>8</sup> This term is defined as someone with standing in the community (*EHD* II, p. 875). The word suggests a vassal who would follow their lord in battle (*A-S*, p. 247; *OED*, *ge.neat*). This definition gives evidence for members of the village serving under the lord of the manor (4.1.4).

<sup>9</sup> The *thegn* was a landlord or a soldier and this term was in use in Latin until the end of the twelfth century (*DMLBS*, XVII, p. 3430).

<sup>10</sup> The original document listed the positions hierarchically with the thegn at the top (*EHD* II, p. 875-8). The original terms were derived from a website which displays the Old English and modern texts (University of London & King's College London, 2015). <http://www.earlyenglishlaws.ac.uk/>

joined the ranks of the fighting men and who might have had the valuable skills necessary to provision them at Hastings.

## 6.2.2 Population Distribution

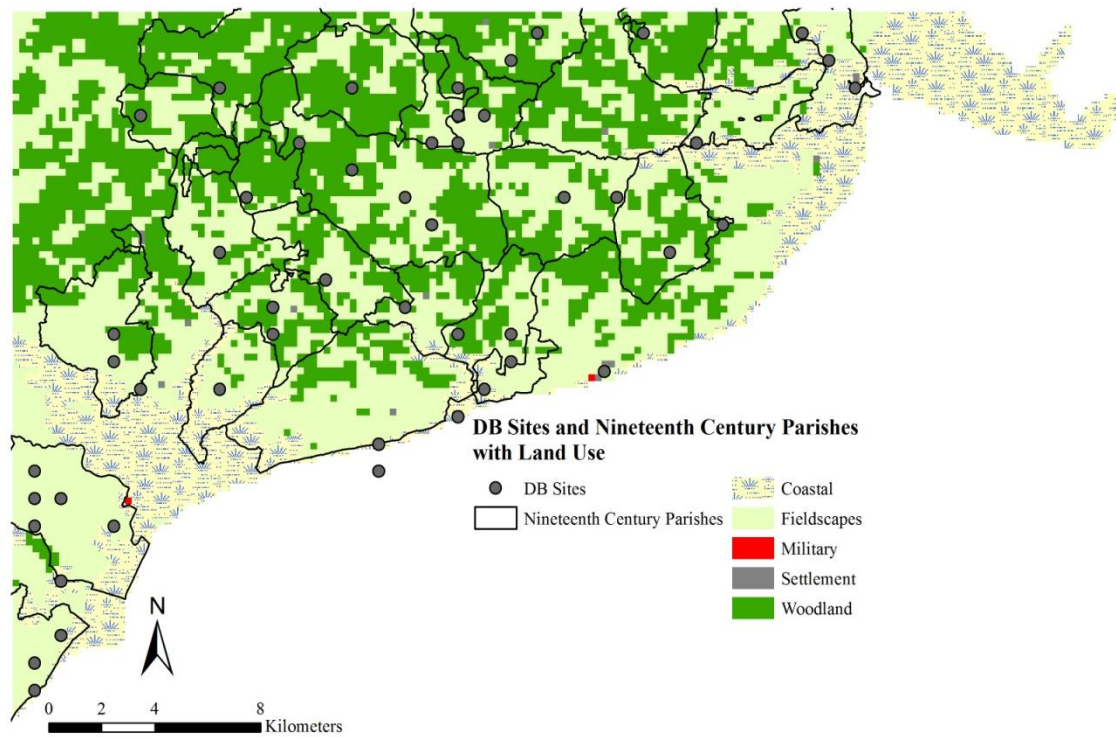
This section examines the location of population resources at the time of the battle.

Figure 6.4 presents the population map for the Hastings area. This map was derived from two datasets. The first is a GIS dataset from Kings College London. The second is derived from the UK Data Archive (Palmer, 2010). These data were joined together based upon the Phillmore codes and then summarized by code and location. In terms of total population, the databases were compared to the Darby maps of Sussex, in turn based on nineteenth century parishes (1977, p. 92). Using the nineteenth-century parish dataset, the parishes were aggregated together based on Darby's maps and supplied with data (Burton, Westwood, & Carter, 2004). This process revealed a rough estimate of the total population. However, when the values were compared, Darby's estimation for some areas was either higher or lower than the total number of people reported in the database. Since the database is by manor and village, then it would be more realistic to consider those values as they have not been aggregated. Non-aggregated data are preferred since the way in which the data are aggregated can influence the results (see Chapter 3 on the Modifiable Areal Unit Problem or the ecological fallacy).

Interpolation of the *DB* population was based on an example provided by English Heritage (Lowerre, 2008). The interpolated surface was calculated with an IDW function. However, the *DB* counts had to be modified to obtain workable values. The range of the interpolation was determined by first finding the average area of every parish with a *DB* record within its boundary and then estimating the radius as if it were a circle. Figure 6.3 displays the *DB* sites and parishes. This exercise produced an average area of 14.363 km<sup>2</sup> and a radius of 2.138 km. In terms of next steps, the *DB* counts were then multiplied by 4 to obtain the total population in the area. Subsequently, to calculate the population density the total population values were divided by the average parish size. Then, the density values were interpolated over the study area. However, since the densities were for a specific area, it was decided that the values should only be

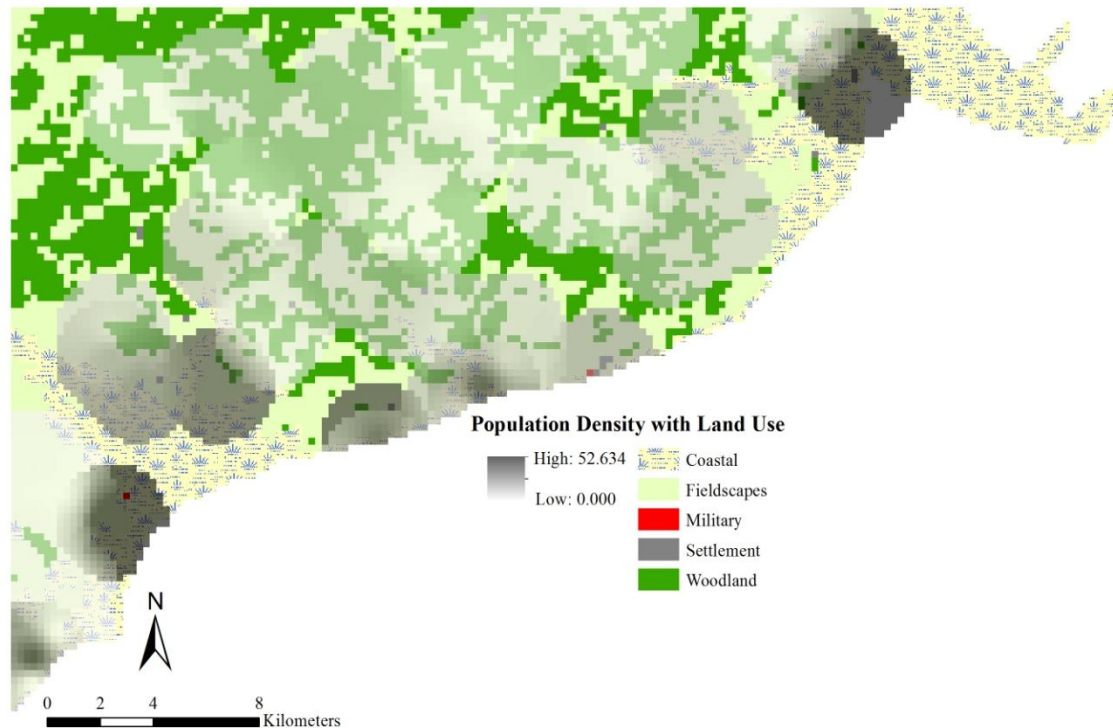


interpolated to that area. Therefore, in the interpolation dialog box, the maximum distance was specified as the radius of the area or 2.138 km.



**Figure 6.3: Hastings Area *DB* Sites and Nineteenth Century Parishes<sup>11</sup>**

<sup>11</sup> This map includes data from a selection of sources (Burton, Westwood, & Carter, 2004; Palmer, 2010).



**Figure 6.4: Estimated Hastings Area Population Density in c. 1066<sup>12</sup>**

The interpolated population map presented in Figure 6.4 indicates that the areas with the largest population were along the coast and particularly in the Pevensey area. When compared to the land use map, this area contains extensive fieldscapes and marshland. The areas with lower population densities were located further inland which corresponds to large areas of woodland where few people would have been living. Overall then, this distribution suggests that the population centres were relatively distant from both army camps (except William's garrison at Pevensey), in turn suggesting that their contribution as a resource to either side may be relatively limited.

### 6.3 Food Availability

One of the most important considerations for a military commander was the supply of food for their men and horses. From the 1066 campaigns, it is known that the English ran

<sup>12</sup> The calculations behind this map are based upon a selection of sources (Burton, Westwood, & Carter, 2004; Palmer, 2010; Lowerre, 2008).

out of food in early September and disbanded their forces before the Normans arrived (ASC (C), 1066, p. 196).<sup>13</sup> By comparison, some historians have assumed that the Normans had plenty of food going into the campaign (Bradbury, 1998, p. 124). Either way, given the sizes of the armies, it is likely that considerable provisions would have needed to be procured and at considerable cost. Based upon evidence from the twelfth century, one English king was reported to have paid £550 for supplies during an expedition to Ireland. Out of the total, £320 went to wheat<sup>14</sup>, £120 to meat such as pork, £45 to further supplements to the diet such as cheese, beans and wine, with the final £65 for oats for horses (Morillo, 1994, pp. 124-5).<sup>15</sup> This funding bought “6424.5 measures (probably quarters)<sup>16</sup> of wheat, 2000 of oats, 584 of beans, with 4106 bacon pigs, 160 quarters salt and 840 weys of cheese” (Prestwich M. , 1996, p. 249).

It is likely that both commanders in the Battle of Hastings would have supplied their armies in a similar manner. In addition, foraging would have also been important method of supplying the army, particularly since William could not have known when Harold would arrive (Morillo, 1994, p. 101).<sup>17</sup> It is believed that foraging took place as the *BT* depicts it occurring (Plate, 47) and the Penitential Ordinance (c. 1070) assigned penance to soldiers who killed locals while obtaining supplies. However, according to its interpreter, the foraging clause was only meant for the period between the battle and William’s coronation (Cowdrey, 1969, p. 235). Nonetheless, the original transcription

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<sup>13</sup> The disbanding may have just been after the required two months had expired (Morillo, 1994, p. 73; Hollister, 1962, pp. 86-7). Therefore, Harold could not have kept them as their required amount of service was over.

<sup>14</sup> “Bread was the staple of Anglo-Norman armies” (Morillo, 1994, p. 124).

<sup>15</sup> In the 1150’s to 1170, the daily pay rate for a knight was 6 – 8d while a foot-soldier was 1d (Contamine, 1986, p. 94). In late Anglo-Saxon England and likely in France as well, the rate for a mercenary was 4d per day (Morillo, 1994, p. 62).

<sup>16</sup> Quarters were equal to seams which typically weighed 120 lb or 54.431 kg but they could weigh 100 lb or 45.359 kg (Zupko, 1968, pp. 137-8 and 153).

<sup>17</sup> Morillo goes into detail about the various goals of plundering by armies (1994, pp. 98-102).

did not specify between the campaign and battle (Brown, 1995, p. 157; Cowdrey, 1969, pp. 241-2).

In terms of rates of consumption, it has been estimated that in northern Europe the local population would have consumed on average about 1500 kilocalories per day (Campbell, 2000, pp. 401-2). Fighting men, on the other hand, would have been consuming about twice that, or 3000 kilocalories per day. Furthermore, to acquire and maintain this food and distribute it throughout the army, would have required a strong administration which in a foreign hostile land would likely have been problematic (Davis, 1987, p. 80).<sup>18</sup> We do know, however, that William's invasion occurred later in the year when more of the harvest would have been collected. In fact, William sailed on the feast of St. Michael which marked in theory the end of the harvest (Miller & Hatcher, 1978, p. 109). The question of how much of this harvest both sides would have had access to has not however, been properly investigated to this point. It is to this task that the next section turns its attention.

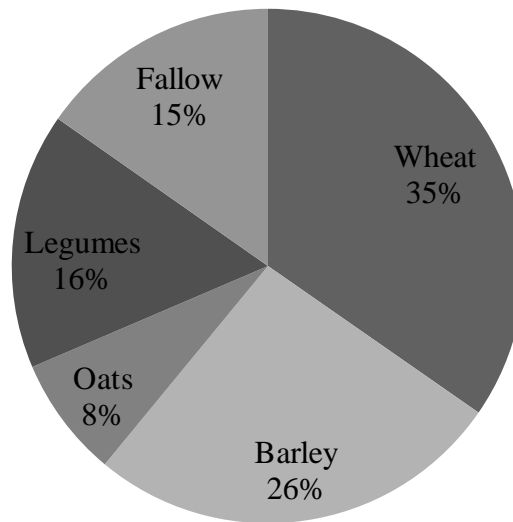
### 6.3.1 Crops

Crop yield data, relevant to the question above, can be derived from "surviving medieval manorial accounts . . . [which] contain all the information . . . [to calculate] the yields of specific crops . . . in dated years" (Campbell, 2007). Based upon data for several manors in Sussex in the late fourteenth century, the percentage of each crop type grown can be estimated. This estimation is presented below in Figure 6.5 and was developed by the author from data presented in an article on late medieval agriculture (Brandon P. F., 1971a, p. 127). The diagram indicates that the most common crop grown was wheat followed by barley. This evidence also appears to suggest that the crop yields in East Sussex were broadly distributed by crop type. When considering all crops, Table 6.1 indicates the potential number of people the Hastings area could have supported.<sup>19</sup>

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<sup>18</sup> One historian reported that William's army brought all of their supplies from France however, based on the simple calculation above, that claim is called into question (Bradbury, 1998, p. 124).

<sup>19</sup> In the Hastings area, farming was done through enclosed fields as opposed to an open-field the two or three crop rotation system (Baker, 1973, pp. 423-4; White, 2012, p. 61). The crop rotation system simply



**Figure 6.5: Per Cent of Demesne Arable Crops in Fourteenth Century Sussex<sup>20</sup>**

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indicates how much of the field will be pasture. In the eleventh century it has been estimated that 56 per cent of the arable was farmed at any given time (Campbell, 2000, p. 396).

<sup>20</sup> Figure 6.5 was developed from data presented in an article on fourteenth century agriculture in Sussex (Brandon P. F., 1971a, p. 127).

**Table 6.1: Estimating the Grain Yields and Population in 1066**

Variable	Estimate 1			Estimate 2			Estimate 3		
	A	B	C	A	B	C	A	B	C
Arable Area	27468	44940	47487.5	27468	44940	47487.5	27468	44940	47487.5
Grain Area (56% of Arable Area)	15382	25166	26593	15382	25166	26593	15382	25166	26593
Kilocalories per Acre	670075	670075	670075	670075	670075	670075	558396	558396	558396
Harvested Grain (kcal - x10 <sup>10</sup> )	1.031	1.686	1.782	1.031	1.686	1.782	0.859	1.405	1.485
Processed Grain including Wastage (kcal - x10 <sup>9</sup> )	5.772	9.443	9.979	5.155	8.432	8.910	4.295	7.026	7.425
Daily Supply (kcal - x10 <sup>7</sup> )	1.581	2.587	2.734	1.412	2.310	2.441	1.177	1.925	2.034
Potential Population	10542	17248	18226	9416	15400	16273	7844	12834	13561

Estimate 1 is based upon kilocalories per acre in 1300 and a processing rate (with wastage) of 0.56 while estimate 2 uses a processing rate with wastage of 0.5. Estimate 3 reduces the kilocalories per acre by 20% and uses the processing rate from estimate 2 (Campbell, 2000, p. 397).

Table 6.1 was calculated by the author using a method contained in Campbell's book on English medieval agriculture (2000, p. 397). In the book, Campbell estimated the total arable acreage in 1066 through two methods, both presented in the table, as well as acreage according to a method developed by Maitland.<sup>21</sup> These numbers correspond to the estimates presented in Section 6.1.1. Key variables as discussed below were manipulated to provide a series of three estimates of the population potentially supported by the arable land available. The grain area was calculated by multiplying the arable land estimate by a factor of 0.56 per cent. The harvested grain was deduced from the grain area multiplied by the number of kilocalories per acre. The amount of processed grain was obtained by multiplying the harvested grain by the processing rate as indicated in the note below the table. This value was then converted into daily supply by dividing it by 365 days. To obtain the number of people which could be supported under the various scenarios, the daily supply was divided by 1500 kilocalories per head. The final value was then rounded to the nearest whole value (Campbell, 2000, p. 397).

Although it cannot be known how much grain was sold outside the area, the table indicates that the number of people who could in theory be supported ranges from approximately 7840 to 18230 people. The average across all the estimations was 13483 people. Based upon the recorded population in the *DB* of 1171 (see above) and considering a multiplier of 4, 4.5 and 5 (Darby, 1977, pp. 87-91) as well as a ten per cent error estimation above and below the estimated figures, the supported population could have ranged from 4216 to 6441 with an average of 5270 people. Thus, the Hastings area would have supported numbers well beyond the recorded population.

However, could it have supported the English and Norman armies, and for how long? In the literature, William's army ranged in size from 6000 men and 1500 horses to 14000 men and 3000 horses. In this study, it has been estimated that William's army was approximately 8000 men and 2000 horses. William's fighting men would have required more food than the average local inhabitant, previously estimated at 3000 kilocalories per

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<sup>21</sup> Campbell used Seeböhm and Lennard's methods for estimating the arable acreage (Campbell, 2000, pp. 386-9).

day. The amount of food required for the horses has been open to debate. Bachrach has indicated that the daily requirements would have been approximately 5.5 to 6.5 kilograms of grain and hay each, per day (1985, p. 12). Another historian, Davis suggests small horses and lower feed values at around 4.5 kilograms of grain and hay each per day (1987, p. 80).<sup>22</sup> His evidence, which he considers an estimation (Davis, 1987, p. 80), was recorded in *modii*, a unit of measurement known to vary in size (Zupko, 1978, pp. 116-20; Davis, 1987, p. 75). Values which better represent the middle ages were perhaps presented by Langdon, who, using later medieval data for cart-horses, indicates that they would have been eating approximately 6.65 quarters of oats per year or 8794.179 kilocalories per day (2.380 kg per day) (1982, p. 33).<sup>23</sup> These values can be applied to warhorses as Hyland in her book states that carthorses and riding horses were the same size at 15 hands (1998, p. 28 and 33). To provide a range of values, and to keeping in line with other existing estimates, values from a low of 2.380 kg per day (as suggested by Langdon), to a high of double this amount, at 4.760 kg per day (as suggested by Bachrach and Davis) were used to calculate the total amount of food required for the two armies at Hastings. These estimates are presented in Table 6.2.

Table 6.2 indicates the number of kilocalories and kilograms of food for an army of four sizes. Column 3 (Kcal/day) is calculated by multiplying the number of men by 3000 kilocalories per day and the number of horses by 8794.179 or 17588.358 kilocalories per day for their lower and upper limits of food. Column 4 (Kg/day) is calculated by multiplying the number of men by 0.895 kg/day and the number of horses by 2.380 or 4.760 kg per day for their lower and upper limit of food in terms of weight. These figures indicate that William's army required between  $3.119 * 10^7$  and  $9.477 * 10^7$  kilocalories

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<sup>22</sup> The grain is included in the calculation with the rest of the army. The hay is expected to come from the pasture or fallow fields which would have accounted for approximately half of the local fields.

<sup>23</sup> Langdon's value is used in the calculations because he provides evidence from later medieval records when measurements were standardized (1982, p. 33). The value of 8794.179 kilocalories per day was calculated by multiplying 6.65 by 288 (weight of a quarter of oats), 1676 (number of kilocalories in a pound of oats) and then dividing by 365. The amount of kg per day was calculated by dividing the kilocalories per day by 1676 and then multiplying by 0.4536 (Campbell, 2000, p. xxv and 392).



per day or  $0.894 * 10^4$  and  $2.681 * 10^4$  kg per day.<sup>24</sup> Evidence suggests Harold had a similarly sized army with horses for riding; therefore, his forces would have had similar dietary needs as William's. Given the data presented in Tables 6.1 and 6.2, the amount of time in days the armies could have lasted in the Hastings area can be calculated.

Assuming the smallest processed grain ( $4.295 * 10^9$ ), a local population of 6441, and two armies of 14000 men and 3000 horses each, with horses eating at 4.760 kg per day, both armies could have only lasted four days. As William waited for two weeks this estimate is highly unlikely. On the opposite side of the range, with the largest possible amount of processed grain ( $9.979 * 10^9$ ), smallest local population (4216), and armies possible (two armies of 6000 men and 1500 horses, eating at 2.380 kg per day); Harold and William's men and horses could have lasted four months. However, the reality was likely somewhere in between. With an average amount of processed grain ( $7.382 * 10^9$ ), combined with a local population of 5270, two armies of 9000 men and 2500 horses each, and the horses eating between the extremes at 3.570 kg per day, then both armies could have lasted a little over a month. Therefore, without taking vital food supplies from the local population, it is likely that both Harold and William's men would have been able to acquire sufficient food during their stay in the Hasting area even had the campaign been prolonged past mid-October 1066.

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<sup>24</sup> It is unlikely that William's men would have brought all of their food with them. However, it is possible that some of William's ships returned to France following the landings for supplies (Gardiner, 1999).

**Table 6.2: Estimated Kilocalories and Kilograms required for William's Army per Day<sup>25</sup>**

	Men	Horses	Kcal/day (10 <sup>7</sup> )	Kg/day (10 <sup>4</sup> )
<b>Minimum Army</b>	6000	1500	3.119 - 4.438	0.894 - 1.251
<b>Maximum Army</b>	14000	3000	6.838 - 9.477	1.967 - 2.681
<b>Small Likely Army</b>	8000	2000	4.159 – 5.918	1.192 – 1.668
<b>Large Likely Army</b>	9000	2500	4.899 - 7.097	1.401 - 1.996

### 6.3.2 Domestic and Wild Animals

More than just grains, Harold and William's fighting men would have required meat as well, including both domestic and wild animals. In terms of domestic animals, the *BT* provides much evidence of food acquisition including a scene depicting men taking farm animals for use by the army (Plate, 47). Local animals which would have been available to the armies included poultry<sup>26</sup>, cattle, pigs, ponies and sheep. Cattle, pigs and sheep were an important commodity by the twelfth century with their remains located in castles, towns and villages (Grant, 1988, p. 152). Additionally, these animals would have provided other resources such as milk from cattle or eggs from chickens and geese. Therefore, the local domestic animals would have been an additional resource and consideration for the armies and locals in 1066.

While primarily hunted for sport, wild animals were seen as occasional sources of food (Hoffmann, 2014, pp. 188-9). Thus, it is important to consider which ones were living in the area. Of particular interest to the armies would have been the local deer and boar populations (V. C. H. *Sussex* I, pp. 305-7).<sup>27</sup> In the marshy areas and rivers, there would

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<sup>25</sup> The data assembled in this table came from several sources (Campbell, 2000, p. 397; Bachrach, 1985, p. 12; Davis, 1987, p. 80; Huscroft, 2009, p. 121; Langdon, 1982, p. 33; Lawson, 2003, pp. 141-3 and 176-8).

<sup>26</sup> This includes chickens, ducks, and geese.

<sup>27</sup> Other mammals of interest might have included badgers, foxes, otters and weasels (V. C. H. *Sussex* I, pp. 302-3).

have been plenty of fish especially salmon and sea-trout (V. C. H. *Sussex* I, pp. 267-70).<sup>28</sup> In terms of birds, there were many different types across the landscape with the diversity in the large marshes being exceptionally noteworthy (V. C. H. *Sussex* I, pp. 273-98). Thus, should the commanders have decided to hunt, the Hastings area would have had plenty of different types of wild animals to choose from.

In summary, there were many different food resources available to the armies in 1066. The agricultural yields in the area suggest both sides could have obtained sufficient grain and resources over the short term. However, to ensure a healthy fighting force, the armies would have accessed the vast quantity of animal resources available. Thus, the armies in 1066 would have located more than enough food to sustain their stay in the Hastings area.

## 6.4 Industrial Requirements

This section provides an overview of the local industries which would have provided important supplies to the English and Norman armies in the area. These include iron sites, grain mills, salt houses and wood suppliers. These resources were important at the time because they provided the armies with armour, food processing and preservation as well as construction of defenses. Each type of industry in the Hastings area is mapped and analyzed in turn in the sub-sections which follow.

### 6.4.1 Iron Sites

According to Darby, “[i]ron-ware must have been in widespread use in the eleventh century, but we hear little in Domesday” (1977, p. 266). Therefore, other sources should be consulted with respect to local metal use. One author, Brandon has noted that there was an active mining industry in Sussex (1974, pp. 148-50).<sup>29</sup> He also indicates how the

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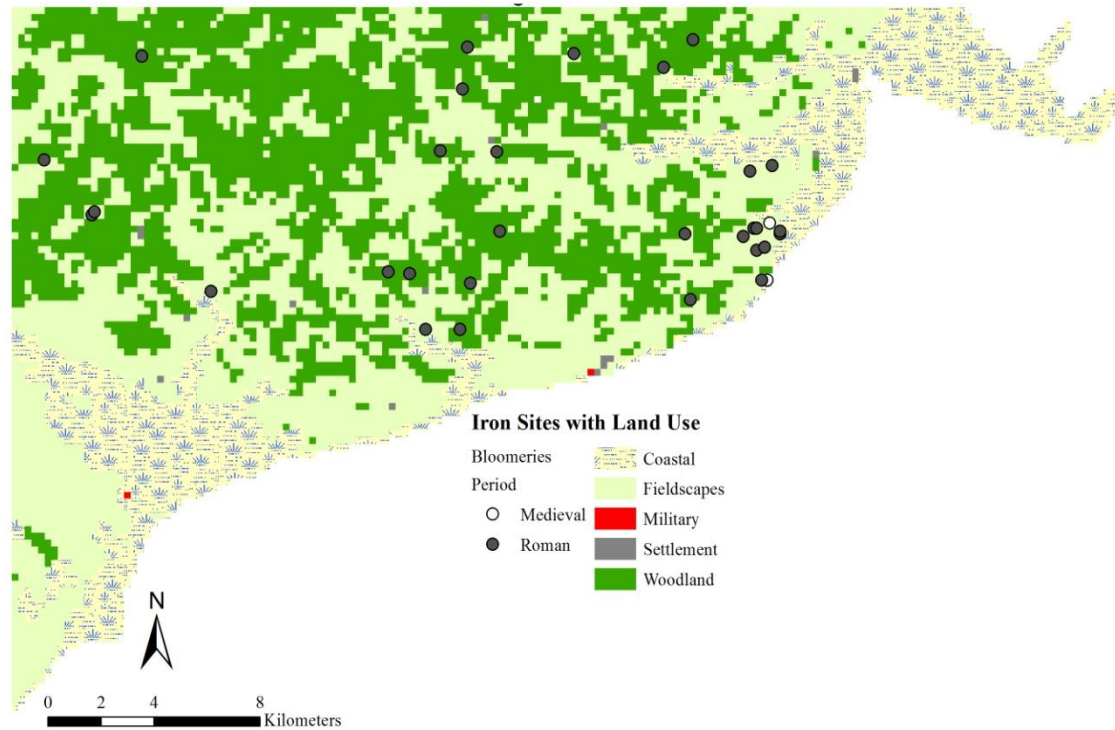
<sup>28</sup> Fish were important to medieval Europeans as they were instructed to not eat land animals once or twice a week (Hoffmann, 2014, p. 192).

<sup>29</sup> Based on a map in an environmental history textbook, South East England was predominantly used for iron production and smelting (Hoffmann, 2014, pp. 216-7). In the eleventh century, iron smelting was done through a bloomery. A bloomery was a contained furnace where the iron was heated so the impurities

local iron was extracted from the rock and that these sites can be approximately dated. These locations can be accessed from a database maintained by the Wealden Iron Research Group (Brandon P. , 1974, pp. 148-50; Wealden Iron Research Group, 2013). However, it is also noted that the extent of pre-Conquest English mining is not known and thus, sites which were active in Roman times may not have been active at the time of the Norman Conquest. Nonetheless, Brandon does point out that it is likely settlement continued around the old mines into the Anglo-Saxon period (1974, pp. 76-7). Therefore, William's men could have potentially accessed iron to repair their weapons during their stay in the Hastings area. Figure 6.6 presents the local iron sites with the time period indicated as well. Note the many sites which were classified as Roman versus medieval. This trend indicates the growth of iron mining in the Roman period and its possible continuation at those sites into the medieval period – therefore providing a source of fresh iron for armaments or armament repair to the Normans.

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would be separated from the iron. The product was known as a bloom and if kept hot could have further impurities removed manually (Hoffmann, 2014, p. 223).



**Figure 6.6: Estimated Hastings Area Iron Sites in c. 1066<sup>30</sup>**

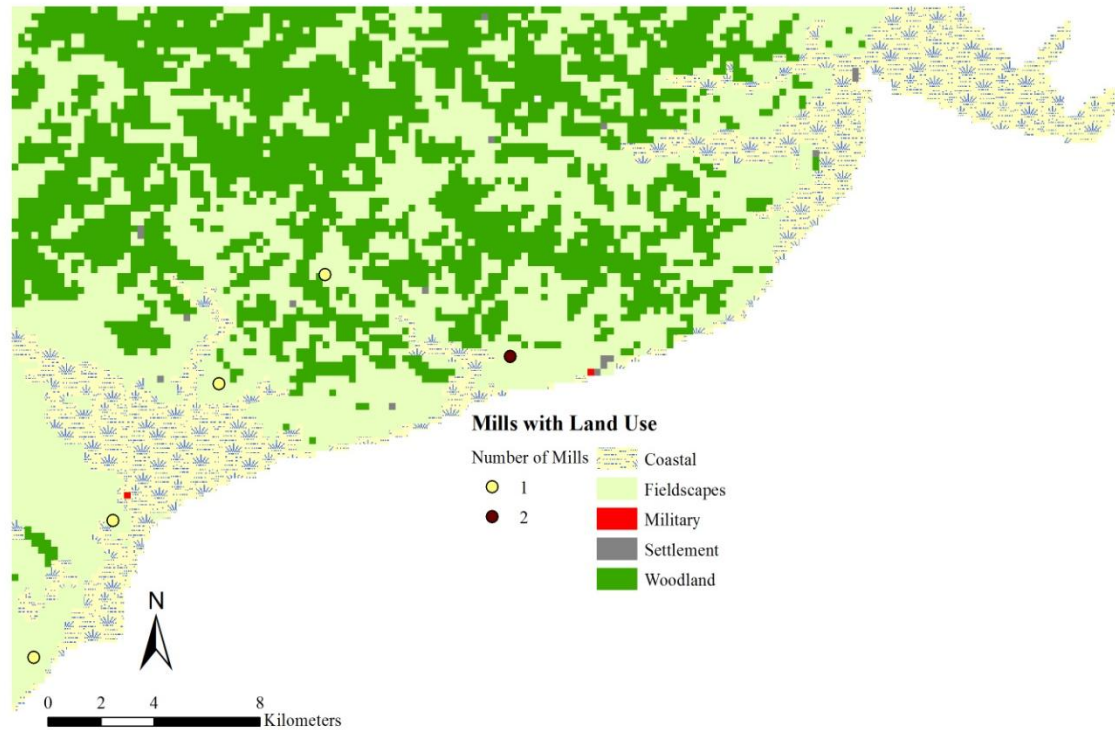
#### 6.4.2 Mills

At the time of the Domesday survey, it has been estimated that there were around 6000 mills in England. It has been assumed that these mills were water-mills which had existed in the country since the mid-eighth century (Darby, 1977, pp. 270-2). The locations of the mills at the time of Hastings is important since, as was indicated earlier (note 14), bread was a staple of the Norman army and William's men would have needed to mill the wheat they obtained to produce flour for bread. Therefore, having a number of mills in close proximity to the encampment would have been ideal.

Based on evidence in the *DB*, Figure 6.7 was developed to graphically illustrate the locations of the mills in the Hastings area. The majority of the mills in Sussex were to the West of the area under study (King, 1962, p. 459). Therefore, the Normans had

<sup>30</sup> The locations of the iron sites were accessed from the Wealden Iron Research Group (2013).

access to few mills in the area. This suggests that soldiers may have ground the wheat manually (Darby, 1977, p. 270), or processed their food supplies elsewhere.



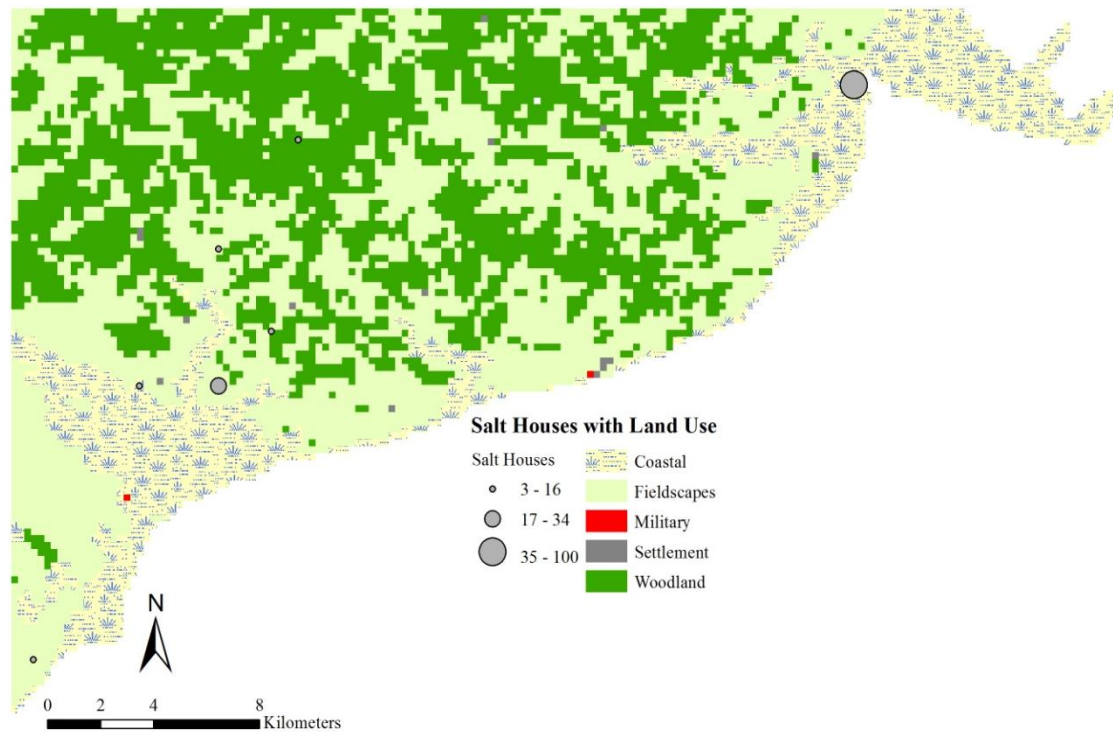
**Figure 6.7: Estimated Hastings Area Mills in c. 1066<sup>31</sup>**

### 6.4.3 Salt

The use of salt was important in the Middle Ages particularly as a meat or fish preservative (Keen L. , 1989, p. 134; Darby, 1977, p. 260). Salt is of interest to the Battle of Hastings because it could have been used by both sides to preserve food into the late fall and winter. There are several works which cover the use of salt and salt production at the time of the Norman Conquest (Keen L. , 1989). The Domesday studies presented by Darby also map salt production (King, 1962; Darby, 1977). Figure 6.8 presents data showing the locations and number of the salt houses. What is interesting about this map is that some salt houses appear to be far inland (King, 1962, p. 457). The best

<sup>31</sup> The number of mills was recorded in the *DB* (Palmer, 2010; King, 1962, p. 459).

explanation, proposed by Darby, was that “the pans entered for some inland manors must have been physically situated elsewhere” (1977, p. 265).



**Figure 6.8: Estimated Hastings Area Salt Houses in c. 1066<sup>32</sup>**

What is more important, however, is that the map indicates that the Norman landing site and camp was ideally situated to access the local salt reserves required for meat preservation.

#### 6.4.4 Wood

“Woods are very stable features of the landscape; like roads and churches, they have outlasted many changes in the societies which they serve” (Rackham, 1980, p. 137). The distribution of wood resources potentially utilized by the two armies can be obtained from the *DB*. However, in the *DB*, the woodland is listed as “x wood for y swine” which is misleading because it does not indicate the extent of the woodland (Darby, 1977, pp.

<sup>32</sup> The number of salt houses was recorded in the *DB* (Palmer, 2010; King, 1962, p. 457).

172-3). There are location concerns as well as some of the woodland may not have been next to the village it belonged to but some distance away (see previous comment pertaining to salt). Consequently, the distribution of woodland as presented above in Figure 6.1, relies upon evidence from the ESHER database. As the figure reveals woodland was readily available to both armies.

Woodland would have been important to the armies for a number of reasons. The most prominent would have been for building castles (*BT*, Plate 51), ships (*BT*, Plate 38) and other defensive works in case of attack.<sup>33</sup> Another important use of wood would have been for charcoal and firewood (Hoffmann, 2014, pp. 201-2). Rackham, in his book on ancient woods discusses in detail the uses of wood in the middle ages such as building material, charcoal, fuelwood, pasture and shipbuilding from underwood and timber. He also includes measurements and prices (1980, pp. 137-47 and 153-6).<sup>34</sup>

## 6.5 Water Availability

This section focuses on the accessibility to fresh water in the Hastings area to the English and Norman armies. The generic hydrologic processes are described in Chapter 5. In this section, the local hydrology is discussed in detail specifically with respect to the stream network, discharge and importance to the armies.

### 6.5.1 Stream Network

In the development of the analysis of the local stream network, the current Ordnance Survey data were not considered, as there have been human modifications to the channels since 1066 (see Figure 1.1) (Ordnance Survey, 2012; Rhodes, 2007). Therefore, the network was derived from a DEM. This information was obtained through the *Whitebox GAT* software (Lindsay, 2007). First the amount of sediment lost since the battle (see Chapter 5) was added onto the current topography. Then, since parts of the area (i.e.

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<sup>33</sup> Lavelle discusses fortifications including signal beacons in his book on Anglo-Saxon warfare (2010, pp. 209-63).

<sup>34</sup> The importance of wood to medieval society is discussed by Hoffmann in his book on the medieval environment (2014, pp. 181-8).

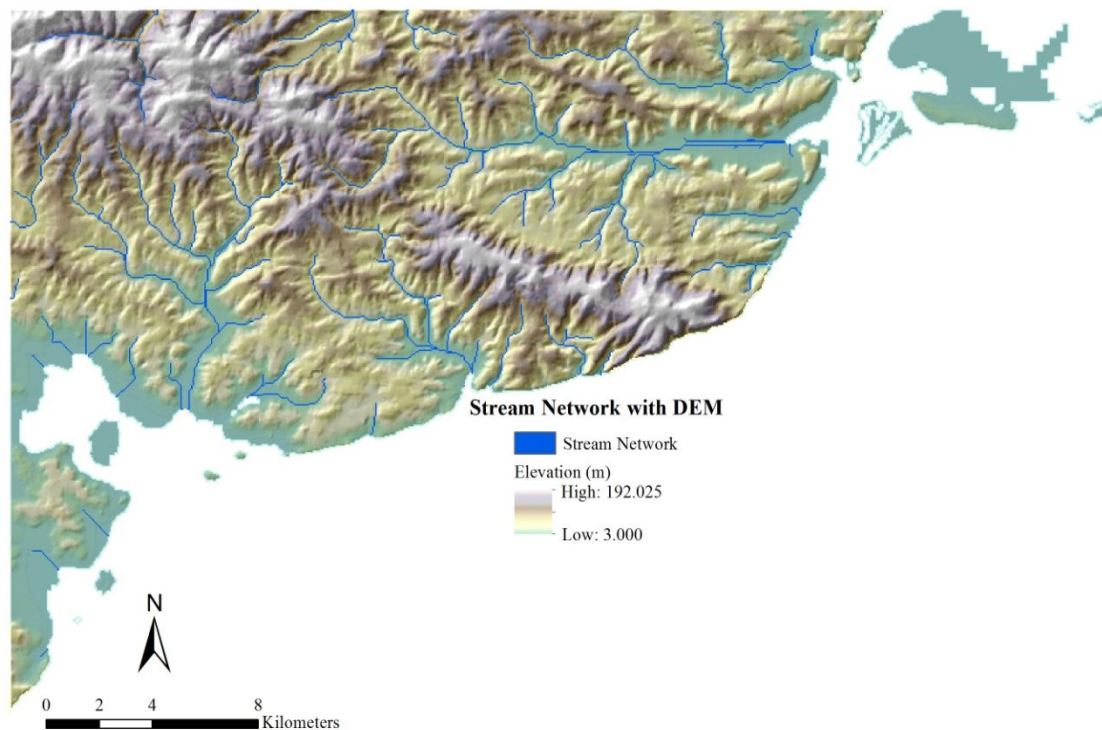


Pevensey and Rye) are both fairly flat, they were removed from the DEM because the model could not provide a reasonable stream network for those areas.<sup>35</sup> In addition only elevations 2.896 m above sea level were selected based upon a high tide of 9 to 10 feet as cited by Salzmann (1910, p. 32). The DEM was then subsequently smoothed to ensure the model could detect the flow of water through the landscape.<sup>36</sup> Next, a flow pointer was created which “stores the flow direction of each cell in a raster grid” (Lindsay, 2010, p. 6). In this model, the most basic flow pointer, the D8, was selected. From here, the flow-accumulation was calculated based upon the flow pointer data. This calculation indicates “the number of grid cells that are connected to each cell in an upslope and downslope direction” (Lindsay, 2010, p. 7). The final step was to extract the streams. This selection was achieved by applying a threshold to the flow-accumulation data. Through trial and error, a threshold of 25000 was selected which yielded a realistic looking river network (Lindsay, 2010, p. 9). The result is displayed in Figure 6.9. Further, Figure 6.10 presents the streams with the local land uses.

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<sup>35</sup> The model was initially tried with Pevensey and the Rye area being left as is. However, the stream network which was developed consisted of straight channels through these areas which appeared artificial. Therefore, the author decided to remove those areas from the model.

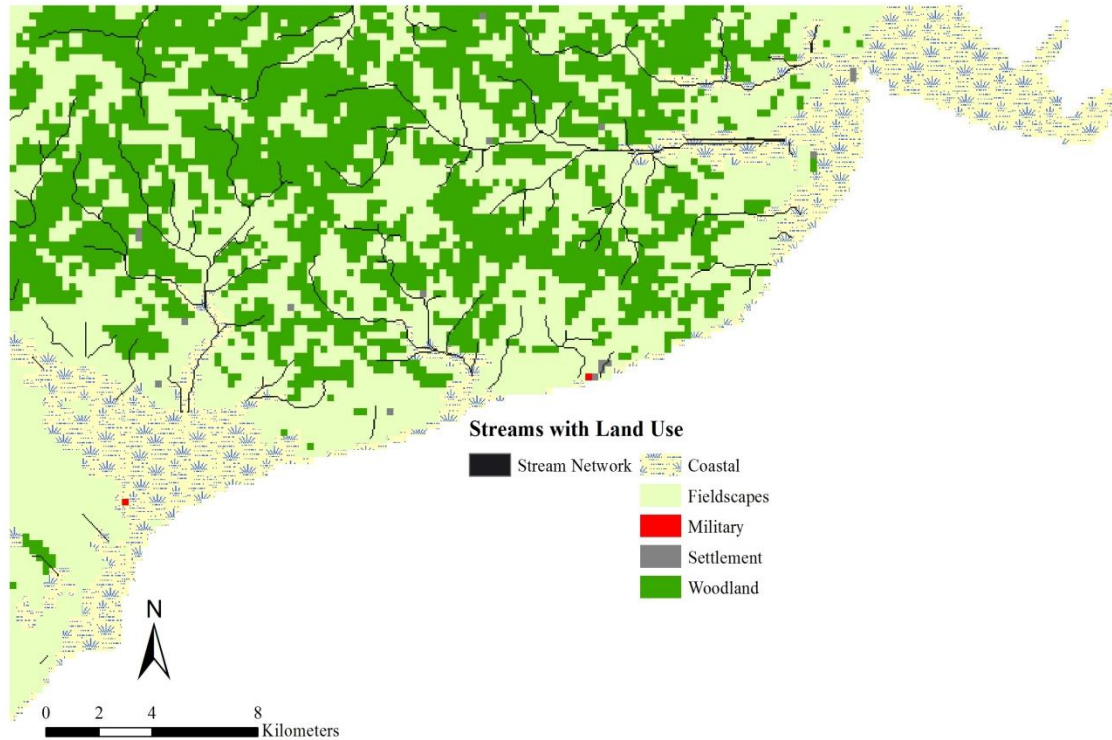
<sup>36</sup> The most common method to smooth a DEM for hydrologic modeling is to use a depression filling function (Lindsay, 2010, p. 5).



**Figure 6.9: Estimated Hastings Area Streams with DEM for c. 1066<sup>37</sup>**

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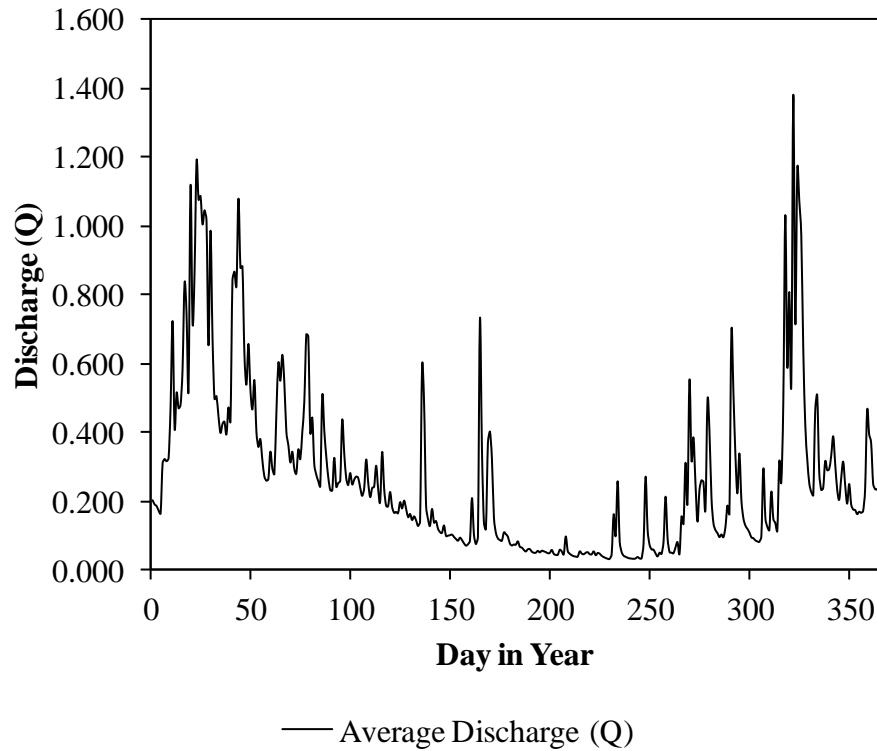
<sup>37</sup> This figure was developed by first calculating the stream network from a DEM (Lindsay, 2010; Ordnance Survey, 2012) and then calculating a hillshade map from the DEM. Next, the DEM was set as transparent and layered on top for the 3-D visual effect known as relief shading (Kimerling, Buckley, Muehrcke, & Muehrcke, 2009, p. 117).



**Figure 6.10: Estimated Hastings Area Streams with Land Use for c. 1066**

### 6.5.2 Stream Discharge

As is indicated in Chapter 5, river discharge indicates the amount of water flowing past a single point over time. For the Combe Haven River, which drains the western part of the Battle area, a discharge graph was aggregated by day for all years from 1970 to 2000. The resultant graph, as presented in Figure 6.11, depicts a generalized view of the local hydrologic trends. As the graph shows, the flow ranges from less than  $0.1 \text{ m}^3/\text{s}$  in the summer months to between  $0.2$  and  $0.4 \text{ m}^3/\text{s}$  in the fall. However, the peak can go much higher with the highest average discharge of  $1.4 \text{ m}^3/\text{s}$  in mid-November. This peak would be caused by increased precipitation on a saturated landscape which would lead to greater runoff. The major implication of these observations is that there would have been an increase in the fresh water available for use in the Hastings area when the Normans and English armies were present.



**Figure 6.11: Average Discharge from Combe Haven Gauging Station for 1970 to 2000<sup>38</sup>**

## 6.6 Conclusion

In summary, this chapter, through the development of a number of cartographic representations, has provided a detailed discussion of the volume and location of the resources likely available to the two armies at the time. Thus, it has advanced a significant measure towards addressing research question 3 and the issue of resources at the Battle of Hastings. The chapter revealed abundant resource availability in the form of crops, animals, iron sites, salt and water. Population resources in the form of skills were less readily available as the main local centres of habitation were some distance from the battle. This was also true of the local mills which were scattered and few in number. All

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<sup>38</sup> For a location of the basin and gauging station, see Figure 2.1 (CEH, 2013).

in all however, it is likely that Harold and William would have been well supplied in the region had the length of stay extended beyond October 14, 1066.

So far, a number of geographic factors have been considered with respect to their impact on the Battle of Hastings as an historical event, including the geopolitical context, mobilization of the armies, landscape changes and in this chapter, the availability of resources. The following chapter moves to address the final two research questions guiding this study, specifically concerning the location, development and outcome of the Battle of Hastings.

## Chapter 7

### 7 The Battle of Hastings: A Geographical Interpretation

In the morning of October 14, 1066, Harold and William, respectively, assembled their forces and marched to fight for the throne of England. Harold arrived to the north or northwest of Battle the previous night from London,<sup>1</sup> whereas William marched from the south or southeast from his camp at Hastings.

In this chapter, based upon a review of existing literary and cartographic sources, the Battle of Hastings itself will be mapped and analyzed through the use of GIS techniques including, buffers, MCDA modeling and querying. Specifically, in addressing research question 4, “*what can HGIS reveal about the potential locations of the battle and which is the most likely*,” the locating of the battle will be discussed within the context of the existing literature on this topic. In addition, the chapter will seek to answer research question 5, “*how did the natural landscape influence the development and outcome of the battle*,” through a step by step map-based analysis of the progression of the battle.

#### 7.1 The Location of the Battle of Hastings

This section evaluates and assesses several possible locations for the battle site. Two of the possible sites are within close proximity of the present town of Battle. Austin, a local historian, has proposed a site further south of Battle that is not widely accepted by the academic community (2012; Grehan & Mace, 2012, pp. 118-9). A fourth site has also been proposed to the east of Battle near Sedlescombe by Tyson, an amateur linguist (2014, pp. lxii-iii). All four sites will be assessed based upon the descriptions of the location in the historical documents and cartographically with a MCDA (Figures 7.2 – 7.4). An initial discussion of the battle site in the historical sources will be presented in this chapter. The information and analysis pertaining to the possible sites of the battle

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<sup>1</sup> Based on *WP*, it is assumed that the English would have likely come from the north or northwest where the woodland was denser.

will be followed by a critical examination of the various locational factors / variables identified in the contemporary sources.

### 7.1.1 Literary Descriptions of the Battle Site

Given the vast number of documents that refer to the Battle of Hastings, it is useful to undertake a systematic analysis of the descriptors of the site that have been used in determining the likely site of the battle. These descriptors are recorded in the context in which they were written, as displayed in Table 7.1, focusing on documents written within the 20 years following the battle. The numbers in parenthesis indicate the number of times a specific word appears in the texts.

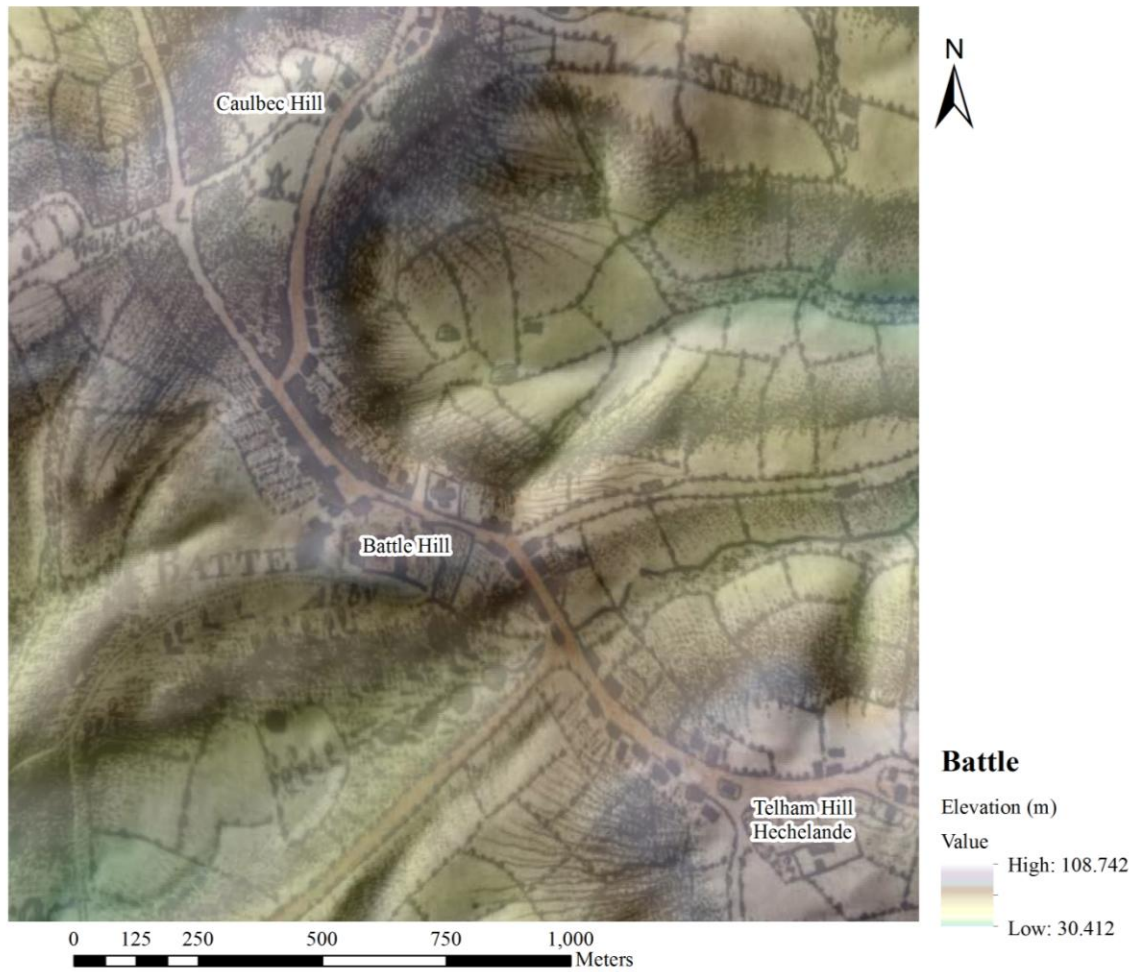
As an accompaniment to the table, Figure 7.1 has been developed as a reference map for the Battle area. Specifically, the locations of Battle Hill, Caulbec Hill, Hechelände and the road network are important in the discussions associated with the task of locating and mapping the battle. In this study the alternative sites suggested by Austin and Tyson are displayed in the MCDA maps, however, only the Battle area is analyzed in detail as the other two sites do not withstand historical academic scrutiny. In regards to the site by Austin, he contends the Norman army was camped at Wilting manor and that the battle took place at Crowhurst (2012, Introduction). Crowhurst is approximately two and a half kilometers south of Battle. There are, however, a number of arguments which have been presented that contradict this view. For example, Austin asserts that Crowhurst is “*Herste*” as mentioned in *BA* (p. 42). Yet, a few pages later, in the *BA*, Crowhurst is mentioned as “*Crohurst*” (p. 48) (Austin, 2012, Chapter 64). The *English Place-Name Society* (1930, p. 502) and the *V. C. H. (Sussex, IX, p. 77)* both confirm that Crowhurst was named Croherst or Crohurst in the eleventh and twelfth centuries. Thus, they cannot be the same place (Grehan & Mace, 2012, p. 119). The main argument against this site, however, is that it “is simply too close to the Norman camp” (Grehan & Mace, 2012, p. 119) for William to have allowed combat to take place. Therefore, this site can likely be discounted. The fourth site proposed by Tyson is located approximately four kilometers to the northeast of Battle. Tyson published her own translation and commentary on the *CHP* which she titled the “*Carmen de Triumpho Normannico*”. She labels Sedlescombe as the site of the battle (Tyson, 2014, p. lxii). However, there are number of concerns

about the reliability of this study with respect to its interpretation of the campaign. For example, of the analyses cited in this thesis, not one supports the presentation of the local geography in Tyson's book (2014, p. xxxvi-lxiv). Brandon's study, which would be the closest in supporting Tyson's interpretation, indicates the area was settled by the *Haestingas* tribe but does not call the area *Haestingas* or *Pevenisel* (1974, p. 70 and 79) as does Tyson (2014, p. xliii). Additionally, upon searching the name Pevensey in the English Place-Name Society, *Pevenisel* was among the historical names for the region, hundred and site of Pevensey (Mawer, Stenton, & Gover, 1930, p. 327 and 443). Therefore, the area slightly north of the Brede basin which she has labeled as *Pevenisel* is incorrect. Furthermore, the Norman chroniclers do not mention either Winchelsea<sup>2</sup> or Rye which they would have had they landed where Tyson suggests. Most importantly, the lack of references and limited consideration of other scholars leads one to question the credibility of Tyson's study (2014).

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<sup>2</sup> Tyson translates the *De Viis Maris* - "Concerning routes by sea" (Hughes, 2012, p. 576) as "[n]ext is Hastings . . . but there is no port there; it is seven miles distant at Winchelsea" (Tyson, 2014, p. lvii). However, this reference has been translated in an academic article as stating that "there is the town and castle of Hastings, though there is no port there, and it is seven miles away from Winchelsea" (Hughes, 2012, p. 592). The present author is selecting the second translation that Hastings was seven miles from Winchelsea as correct in their interpretation of the document.





**Figure 7.1: Battle Area DEM (2012) with Yeakell and Gardner Map (1783)<sup>3</sup>**

<sup>3</sup> This map is based on the study area DEM (Stanfords Business Mapping, 2009) and the Yeakell & Gardner map (1783).

**Table 7.1: Location Terms from Documents written within 20 Years of Battle**

	<b>WP</b>	<b>GND</b>	<b>ASC</b>	<b>CHP</b>
<b>Descriptor Words</b>	Higher ground ( <i>locum editiorem</i> / <i>superioris loci</i> ) <sup>4</sup> Hill ( <i>montem</i> ) <sup>5</sup> Wood ( <i>silvae</i> ) <sup>6</sup> (2) Steep slope ( <i>ardua cliui</i> ) <sup>7</sup> Rough ground ( <i>loci asperitate</i> ) <sup>8</sup> Broken rampart ( <i>praerupti valli</i> ) <sup>9</sup> Ditches ( <i>frequentium</i> <i>fossarum</i> ) <sup>10</sup> unfavourable ground” ( <i>adversitate loci</i> ) <sup>11</sup>	Ancient rampart ( <i>antiquum</i> <i>aggerem</i> ) <sup>12</sup>	grey apple tree ( <i>haran</i> <i>apuldran</i> ) <sup>13</sup>	Forest / Wood ( <i>silva</i> / <i>e</i> ) (2) ( <i>nemus</i> / <i>nemoris</i> ) (3) <sup>14</sup> Hill ( <i>mons</i> / <i>montem</i> / <i>montis</i> ) (5) Valley ( <i>vallis</i> ) Rough ground ( <i>non cultus</i> <i>ager</i> <i>asperitate</i> ) <sup>15</sup> Steep hill ( <i>ardua montis</i> ) Summit ( <i>summo</i> ) <sup>16</sup>

<sup>4</sup> *Locum* is a place (DMLBS, V, pp. 1630-1). *Editioem* suggests a form of statement or declaration (DMLBS, III, p. 747). *Superioris* is simply superior (DMLBS, XVI, pp. 3309-10).

<sup>5</sup> This term can be translated as either a mountain or hill but it could also be a cliff, mound or heap (DMLBS, VI, p. 1832-3).

<sup>6</sup> Woodland and related land uses such as pasture. It could also refer to use of wood as well (DMLBS, XV, pp. 3085-7).

<sup>7</sup> *Ardua* refers to something being steep or with a height (DMLBS, I, p. 122). *Cliui* indicates a slope (DMLBS, II, p. 362).

<sup>8</sup> *Asperitate* refers to something rough (DMLBS, I, p. 137).

<sup>9</sup> The first term indicates attack or that something is abrupt or steep (DMLBS, XII, p. 2422). *Valli* is as it sounds a valley. A suffix with a “u” such as “um” would indicate a palisade or earthwork (DMLBS, XVII, p. 3591-2). Lemmon suggests the text could be spelt incorrectly and could either mean ravine or steep bank (1970, p. 52).

<sup>10</sup> *Frequentium* can be of high density, a large amount or frequent use (DMLBS, IV, p. 1006-7). *Fossarum* refers to a ditch but it could also refer to an embankment, dike, trench or moat (DMLBS, IV, pp. 993-4).

<sup>11</sup> *Adversitate* indicates something is hostile (DMLBS, I, p. 37). *Impedita* suggests difficulty or to reduce movement (DMLBS, V, pp. 1242-3). This term implies hostile place that was difficult to traverse.

<sup>12</sup> The phrase appears to suggest an old hill or earthwork (DMLBS, I, p. 52 and 96). According to Lemmon, this term “may also mean an old mud wall or ancient causeway” (1970, p. 52).

Table 7.2 presents a summary of landscape descriptors originating in later sources, written in the twelfth century and often based upon earlier accounts. Here again, the numbers in parenthesis indicate the frequency of a word in the texts.

**Table 7.2: Location Terms from Documents written in the Twelfth Century**

<b>BA</b>	<b>BR</b>	<b>GR</b>
Battle ( <i>Bellum</i> ) (2) Hedgland ( <i>Hechelande</i> ) hill ( <i>collis, collem</i> ) <sup>17</sup> (2) natural clef ( <i>naturali telluris hiatu</i> ) <sup>18</sup> valleys ( <i>convalles</i> ) waste ground ( <i>vastitate</i> ) <sup>19</sup> rivulets / river ( <i>rivus, flvuii</i> ) <sup>20</sup> deep pit ( <i>baratrum</i> ) <sup>21</sup>	Battle ( <i>Bellum</i> ) hill ( <i>collem</i> ) (2)	knoll ( <i>tumulo</i> ) <sup>22</sup> lower ground ( <i>vallem</i> ) slope ( <i>acriter ad superiora nitentes</i> ) <sup>23</sup> precipitous ditch ( <i>fossatum quoddam preruptum</i> )

<sup>13</sup> *Apuldran* means apple tree and *haran* indicates that it was grey, hoary or old (*DOE*, apuldor, apuldre; A-S, p. 169). The original Old English text is from Cubbin's edited version of *ASC (D)* (1996, p. 80).

<sup>14</sup> This word does not appear to indicate a forest but instead underwood or scrub for pasture, hunting or fuel (*DMLBS*, VII, p. 1904-5).

<sup>15</sup> *Non* means negative (*DMLBS*, VII, p. 1927). The next term is defined as cultivation, crops or ploughland, however, it could also mean care, costume, or religion (*DMLBS*, II, p. 530).

<sup>16</sup> With the word *montis*, *summo* indicates highest summit (*DMLBS*, XVI, pp. 3291-2).

<sup>17</sup> This term has been translated as hill but in general it appears to mean a collar or neck (*DMLBS*, II, p. 383).

<sup>18</sup> Natural and not man-made (*DMLBS*, VII, p. 1890-1). The second term, *telluris*, refers to land (*DMLBS*, XVII, pp. 3382-3). The main Latin word for land, *terra* has an extensive description as well (*DMLBS*, XVII, p. 3412-4). The final word, *hiatu* refers to an opening (*DMLBS*, IV, p. 1153).

<sup>19</sup> This term indicates destruction and waste land (*DMLBS*, XVII, p. 3601-2).

<sup>20</sup> *Rivus* refers to flowing water but in particular a river bank, waterway or stream (*DMLBS*, XIV, pp. 2843-4). *Flvuii* could be a river or a flood (*DMLBS*, IV, p. 968).

<sup>21</sup> *Baratrum* is a religious reference to a pit or Hell (*DMLBS*, I, p. 181).

<sup>22</sup> This term could mean a tomb or internment (*DMLBS*, XVII, p. 3522).

<sup>23</sup> *Acriter* indicates something is fierce, severe or harsh (*DMLBS*, I, p. 21). The next term, *ad* is a connecting word (*DMLBS*, I, pp. 23-5). *Superiora* was defined above. *Nitentes* suggests "to make violent

Table 7.2 Continued.

<i>HA</i>	<i>JW</i>	<i>OV</i>	<i>RR</i>
ditch ( <i>foueam</i> ) <sup>24</sup> (2) Battle ( <i>Belli</i> ) (2) flat land ( <i>planis</i> ) <sup>25</sup>	Nine miles from Hastings ( <i>nouem miliariis ab Heastinga</i> ) narrow place ( <i>arto in loco</i> )	Senlac (2) Ancient rampart ( <i>antiquum aggerem</i> ) Broken rampart ( <i>praerupti valli</i> ) Ditches ( <i>frequentium fossarum</i> )	open country ( <i>champaigne</i> ) ditch ( <i>fossé</i> ) (4)

In Table 7.2, the *BA* provides the largest number of descriptors (11). For example, the author makes numerous references to the terrain in his/her discussion of the battle (*BA*, p. 39). The *BA* additionally states “[t]he English . . . occupied the hill (*collem*) where the church now stands” (1980, p. 39) thus suggesting a location for the battle. The *BR* mentions the abbey as well as a hill (*collem*) twice. William of Malmesbury indicates there was a knoll (*tumulo*), low ground (*vallem*), slope (*acriter ad superiora nitentes*) and a precipitous ditch (*fossatum quoddam preruptum*) (*GR*, p. 455). *HA* makes references to a ditch (*foueam*) twice as well as the site and names it Battle (*Belli*) twice (*HA*, p. 392-5 and 407). However, *HA* does claim the English formed up on “flat land” (*planis*) which is a claim with less supporting evidence (*HA*, p. 388-9). *JW* adds a further detail that the site was narrow (*arto*) (*JW* p. 605). In *OV*, there is reference to the site as being named “Senlac” (*OV*, p. 173). *OV* also emphasizes the topographical descriptions; however, his description of the battle was heavily based upon *WP* and the *GND* (*OV*, pp. 172-7).

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physical efforts . . . struggle” (*DMLBS*, VII, p. 1917). However, the term could also mean shining, to excel, to “be notable”, to support or “to strive” (*DMLBS*, VII, pp. 1916-7).

<sup>24</sup> It could also mean a deep hole or pit (*DMLBS*, IV, pp. 996-7).

<sup>25</sup> The dictionary suggests this term indicates flat and/or open ground “level or open [land]” (*DMLBS*, XI, pp. 2306-7).

Wace makes several references to fields (*champaigne*) and a ditch (*fossé*)<sup>26</sup> (RR, pp. 182-3).

With the information presented in Tables 7.1 and 7.2, there is a considerable number of geographic descriptors available for a detailed analysis of the battle site. The following section quantifies this information in the development of the weights for the MCDA model (Yuan, 2010).

### 7.1.2 Factors in Developing MCDA Model

As a first step in the development of the weights for the MCDA model, the terms from Tables 7.1 and 7.2 were classified into seven categories by source as displayed in Table 7.3. These include an apple tree (1), Battle Abbey (8), elevation (19), hechelane (1), Senlac (2), terrain (22), and wood (8).

**Table 7.3: Frequency of Terms by Category and Document**

	Documents Written within 20 Years of Battle				Documents Written in the Twelfth Century							$\Sigma$
	ASC	CHP	GND	WP	BA	BR	GR	HA	JW	OV	RR	
<b>Apple Tree</b>	1											1
<b>Battle</b>	1				3	2		2				8
<b>Elevation</b>		7		4	3	2	2			1		19
<b>Hechelane</b>					1							1
<b>Senlac</b>										2		2
<b>Terrain</b>		2	1	4	3		2	3	1	2	4	22
<b>Wood</b>		5		2	1							8
<b>Total</b>	2	14	1	10	11	4	4	5	1	5	4	61

Terrain was the most common concept with 22 occurrences spread across the texts. The factor associated with this variable was determined by first calculating the slope (see

<sup>26</sup> The original Old French comes from the edited version by Holden (1971, pp. 185-6). *Champaigne* appears to indicate open land (AND, *champaigne*) while *fossé* is a ditch (AND, *fossé*). However, a *fossé* could also be a defensive feature such as a moat or a grave. It has even been used to describe a creek (AND, *fossé*).

Figure 7.8) and Pennock landscape classification (see Figure 7.9)<sup>27</sup> for the DEM of the Hastings and Battle areas. The slope function was run on the Pennock classification to indicate where the landscape was changing the most. It is assumed that more change would imply a rougher terrain as suggested in the sources. Both the slope and transformed Pennock maps were standardized as benefit attributes (higher values equal higher benefit) and summed together as the terrain map. The terrain map was standardized as a benefit attribute. The second most important concept was elevation or proximity to a hill which had 19 occurrences and was determined from the DEM directly (benefit attribute). Proximity to woodland occurred eight times in the texts and was based on the land use maps in Chapter 6 (lower values equal lower cost). Interestingly, the majority of the wood references were written within 20 years of the battle, yet few were written after that possibly due to deforestation. This fact suggests that the wood factor was not important in the subsequent retelling of the battle.<sup>28</sup> References to proximity to Battle Abbey occur eight times which promoted its importance (cost attribute).<sup>29</sup> The abbey was the only location recorded by the writers that is still known today. Therefore, this factor is important in the analysis of the site of the Battle of Hastings. Additional factors including proximity to the places of Senlac (local streams, as described in Chapter 2) and Hechelane (Figure 7.1) were relevant to the model as well. The “proximity to Senlac” factor was calculated as a stream network using the same method as in Section 6.5.1 above solely for the Battle DEM (cost attribute). The locations of Hechelane and the apple tree were estimated from discussions in the literature and the sources themselves (cost attributes). Despite its single occurrence, the comment in the *ASC* about the proximity to the grey apple tree was of value as it was the

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<sup>27</sup> The Pennock landscape classification analyzes a DEM based on whether it is convergent or divergent or level. The model also indicates if the terrain is the backslope, shoulder or footslope (Pennock, Zebarth, & de Jong, 1987, p. 303; Lindsay, 2007). For further information on landscape classification see *Map Use*, Chapter 16 (Kimerling, Buckley, Muehrcke, & Muehrcke, 2009, pp. 358-60).

<sup>28</sup> This trend could exist because either there was massive deforestation in the late-eleventh-century or the wood was not as important to the battle as once thought. *BA* only mentions wood in reference to the construction of the abbey and not the battle (p. 45).

<sup>29</sup> Factors labeled as in proximity to a location are calculated with the Euclidean distance raster function as discussed in Chapter 4.

only contemporary English perspective on the battle. A later entry of the *ASC* recorded that William founded an abbey where he conquered England ((*E*), 1087, p. 219). In the *BT*, there are scenes showing the local topography including a hill in plate 57 and a “hillock” in plate 67. There is also a water body in plate 66 which together with the hillock have been discussed by Lawson (2003, pp. 149-52). However, as noted before, these images could be artistic and thus may not represent an actual location. A final factor regarding the battle being fought on open land is discussed in 6.1.2 and is mentioned by Wace. This factor is integrated into the model as a constraint with the fieldscapes labeled as “1” and all other areas as “NoData”. Therefore, only open areas will be selected as the possible battle site.

In order to perform MCDA, the various factors were weighted. These factors, as indicated above, were derived from the list of terms in Tables 7.1 and 7.2 and summarized in Table 7.3. To avoid bias in the analysis, the documents were weighted by their time period and origin. The author selected a weight of 50 per cent for all sources within 20 years of the battle and the remaining 50 per cent for twelfth century accounts. The origin of the documents was examined and assessed as English, Norman or Anglo-Norman. Furthermore, it was determined that the English and Norman sources should receive equal weighting, with each perspective worth 25 per cent. Of the four documents written within 20 years of the battle, one document was English while the others were attributed to the Normans and their allies. The twelfth century accounts were Anglo-Norman based. Therefore, the value for the *ASC* was 0.25 or 25 per cent while the three Norman chroniclers were weighted at 0.083 each totaling 25 per cent. As there were seven Anglo-Norman accounts, they were weighted at 0.071 or 50 per cent in total. These weights were then multiplied by the values in Table 7.3. The results are displayed in Table 7.4.

**Table 7.4: Adjusted Values by Source and Category**

	<b>Apple Tree</b>	<b>Battle</b>	<b>Elevation</b>	<b>Hechelande</b>	<b>Senlac</b>	<b>Terrain</b>	<b>Wood</b>	<b>Total</b>
<b>ASC</b>	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.500
<b>CHP</b>	0.000	0.000	0.583	0.000	0.000	0.167	0.417	1.167
<b>GND</b>	0.000	0.000	0.000	0.000	0.000	0.083	0.000	0.083
<b>WP</b>	0.000	0.000	0.333	0.000	0.000	0.333	0.167	0.833
<b>BA</b>	0.000	0.214	0.214	0.071	0.000	0.214	0.071	0.786
<b>BR</b>	0.000	0.143	0.143	0.000	0.000	0.000	0.000	0.286
<b>GR</b>	0.000	0.000	0.143	0.000	0.000	0.143	0.000	0.286
<b>HA</b>	0.000	0.143	0.000	0.000	0.000	0.214	0.000	0.357
<b>JW</b>	0.000	0.000	0.000	0.000	0.000	0.071	0.000	0.071
<b>OV</b>	0.000	0.000	0.071	0.000	0.143	0.143	0.000	0.357
<b>RR</b>	0.000	0.000	0.000	0.000	0.000	0.286	0.000	0.286
<b>Sum</b>	0.250	0.750	1.488	0.071	0.143	1.655	0.655	5.012

Table 7.5 displays the weights that will be used in the development of the MCDA model for the Hastings area. In calculating these, the respective sums by factor were considered (see Table 7.4). These values were then totaled. The weights were generated by dividing



the value by the total.<sup>30</sup> The variables were further weighted with an equal weight across all sources (0.250). The model was additionally run with one variable weighted at 0.4 and the rest at 0.2. Thus, this analysis was calculated for each of the weighting schemes in six simulations.

**Table 7.5: MCDA Weights for Hastings Area Location of Battle Site Model**

	<b>Sum</b>	<b>Weight</b>
<b>Battle</b>	0.750	0.165
<b>Elevation</b>	1.488	0.327
<b>Terrain</b>	1.655	0.364
<b>Wood</b>	0.655	0.144
<b>Total</b>	4.548	1.000

For the Battle area model, a different set of weights were calculated. These are presented in Table 7.6. As this model is more detailed, there are three abstract variables which have been included. These focus on the apple tree as mentioned in the *ASC* as well as Hechelände from the *BA* and Senlac as recorded by *OV*. In terms of the apple tree record in the *ASC*, the weight has been calculated as 0.050, which demonstrates its importance as the only English record of the battle (Tables 7.1 and 4). From this point, the model was calculated over the entire study area followed by the area surrounding Battle. The model was additionally run with an equal weight across all sources (0.143) and with one variable weighted at 0.4 and the rest at 0.1. This analysis was calculated for each of the different weights. Thus, there were nine simulations in total.

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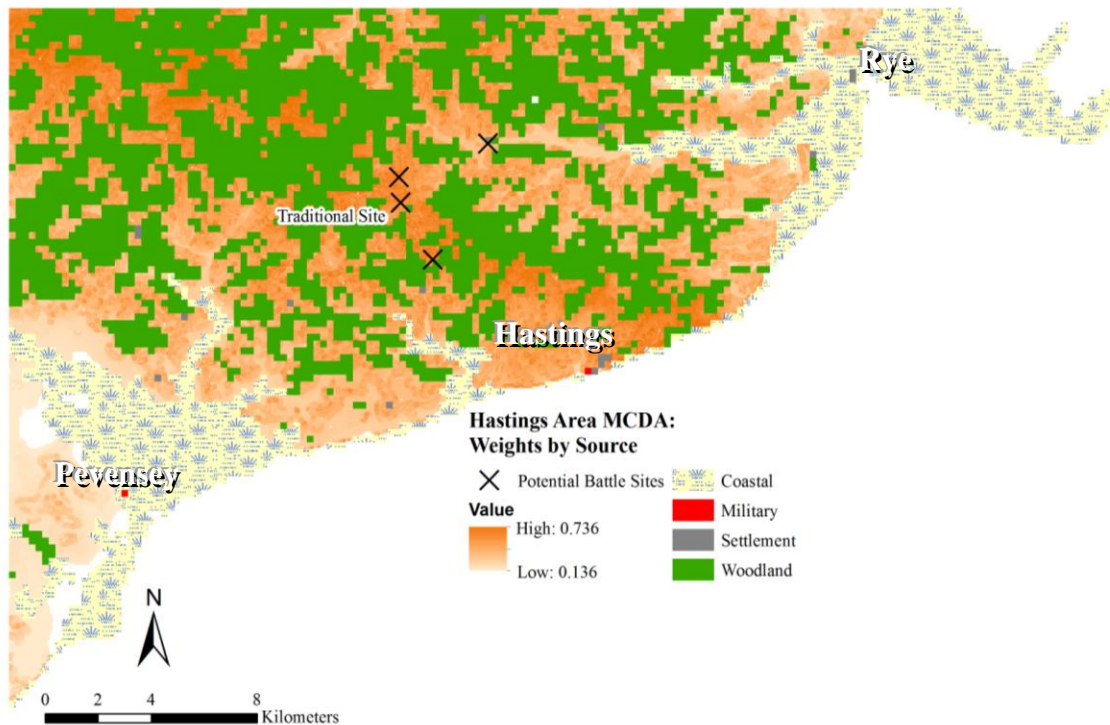
<sup>30</sup> A pairwise comparison matrix was not performed because the relationships between the factors would have to be estimated by the author (Malczewski, 1999, pp. 182-7).

**Table 7.6: MCDA Weights for Battle Area Location of Battle Site Model**

	<b>Sum</b>	<b>Weight</b>
<b>Apple Tree</b>	0.250	0.050
<b>Battle</b>	0.750	0.150
<b>Elevation</b>	1.488	0.297
<b>Hechelande</b>	0.071	0.014
<b>Senlac</b>	0.143	0.029
<b>Terrain</b>	1.655	0.330
<b>Wood</b>	0.655	0.131
<b>Total</b>	5.012	1.000

### 7.1.3 General Location of the Battle over the Hastings Area

Based upon the weights developed in the previous section, the MCDA for the Hastings area was calculated and is depicted in three maps represented in Figures 5.2 to 5.4. The locations identified in the literature as potential battle sites are marked with “X”s on the map. Battle Hill, the traditional site, is labeled as well. The maps include the non-agricultural land uses from Figure 6.1 as reference. The first map, as depicted in Figure 7.2, was calculated with the variable weights in Table 7.5.

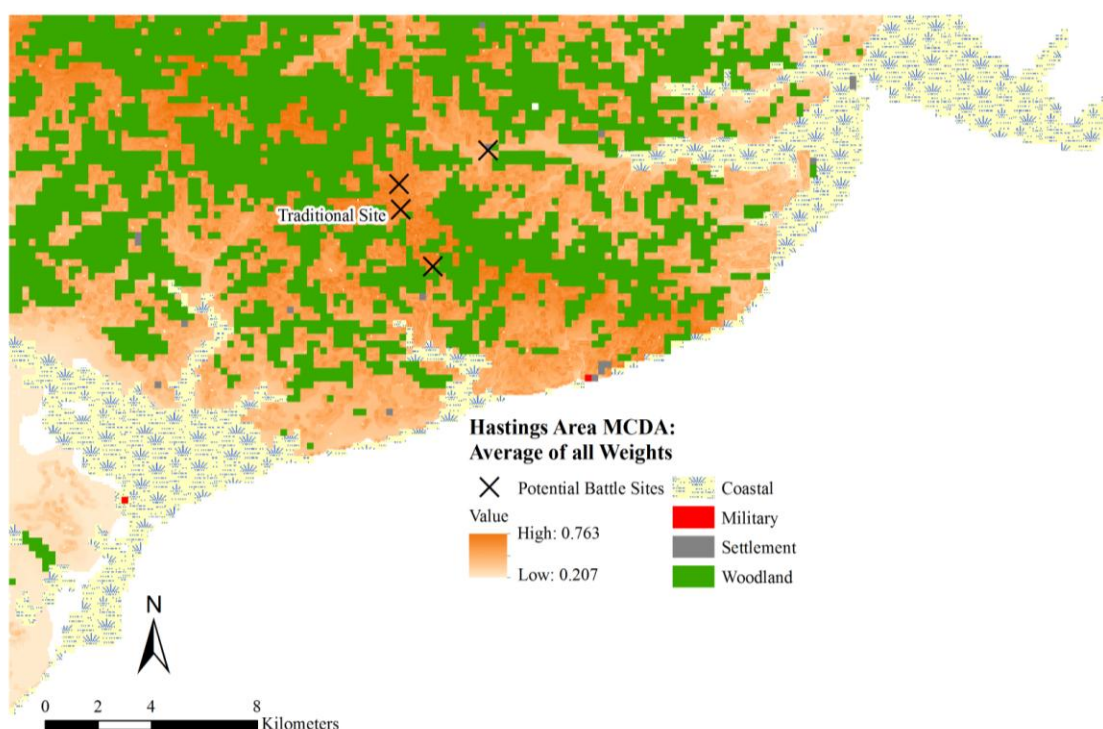


**Figure 7.2: Battle Site in Hastings Area – MCDA Weighted by Source at 50 m Resolution (c. 1066)<sup>31</sup>**

Figure 7.2 indicates that the most likely locations for the battle were along the ridge running northwest up from the coast and particularly along the eastern side of the ridge.

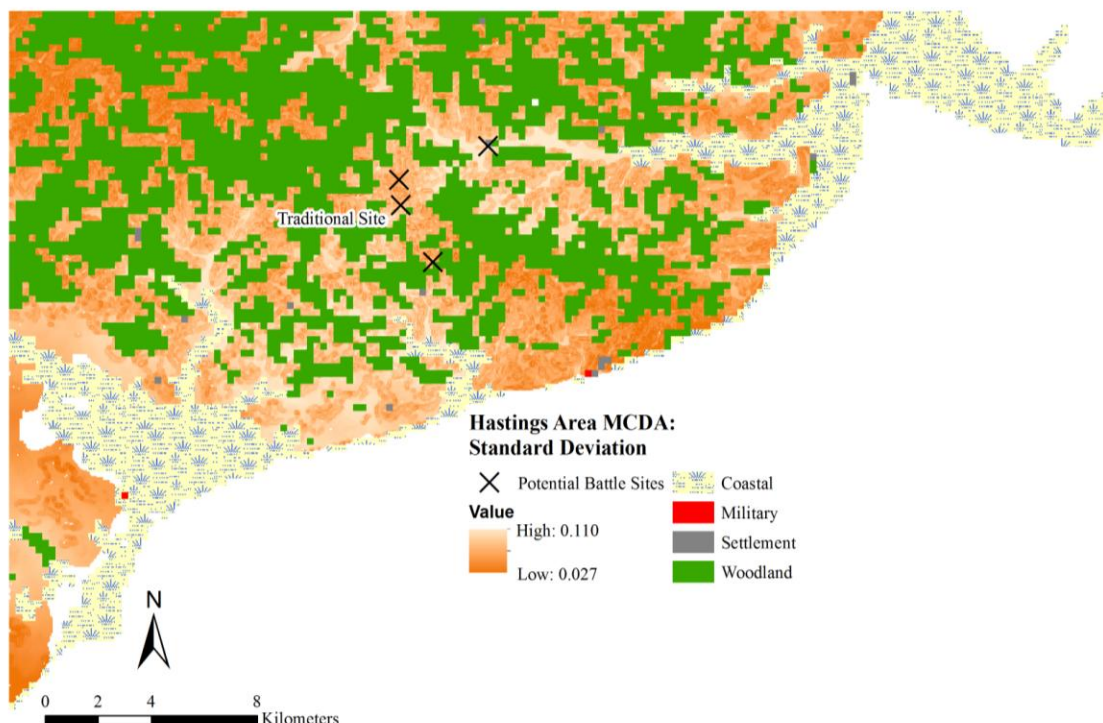
<sup>31</sup> This map is primarily derived from the ESHER (2013) and the OS (2012).

However, the map represents only one set of weights. By applying additional weights, as mentioned above, five other scenarios may be created. The average of these is presented in Figure 7.3. Figure 7.3 reaffirms the findings of Figure 7.2, indicating that a site along the ridge was the most likely for the battle. Figure 7.4 presents findings based on the standard deviation of the weighted results at each pixel. This figure demonstrates that the proposed sites remain in areas of higher probability, but also subject to a slightly higher degree of locational variability. All in all then, the figures tend to support the existing debate as to where battle took place. The following section moves to a more detailed investigation of the two site possibilities in close proximity to the town of Battle.



**Figure 7.3: Battle Site in Hastings Area – MCDA Average across all Weights at 50 m Resolution (c. 1066)<sup>32</sup>**

<sup>32</sup> This map is primarily derived from the ESHER (2013) and the OS (2012).

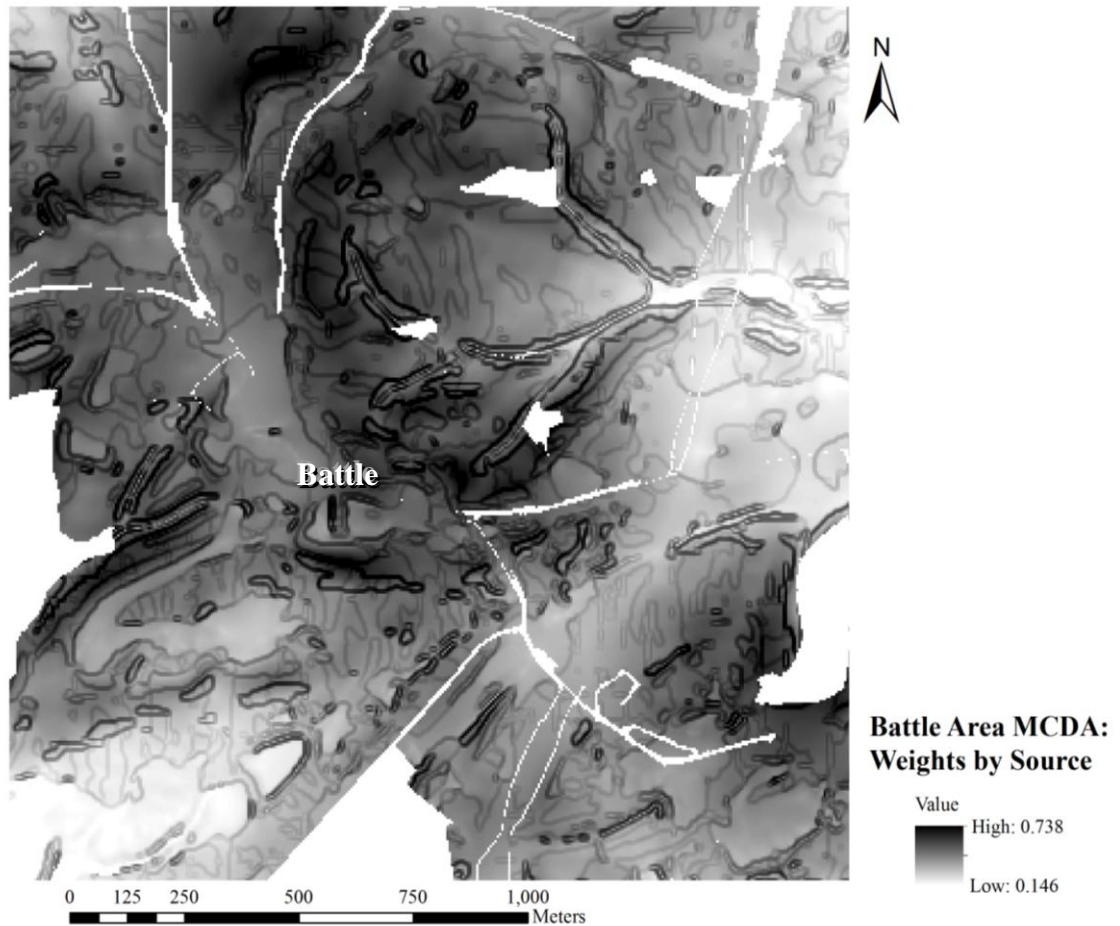


**Figure 7.4: Battle Site in Hastings Area – Standard Deviation of MCDA Results at 50 m Resolution (c. 1066)<sup>33</sup>**

#### 7.1.4 Location of the Battle in the Battle Area

In this section, the results of the MCDA model specific to the Battle area are presented in a series of three maps as shown in Figures 7.5 to 7.7. Figure 7.5 depicts the results based on variable weights for the sources taken from Table 7.6. The results indicate that the highest values on the map, and hence the area most likely for the engagement to have occurred is just to the northeast of Battle Hill, the official site of the battle. The map further indicates several smaller areas to the west, east and north of Battle Hill as possible locations.

<sup>33</sup> This map is primarily derived from the ESHER (2013) and the OS (2012).



**Figure 7.5: Battle Site in Battle Area – MCDA Weighted by Source at 5 m Resolution (c. 1066)<sup>34</sup>**

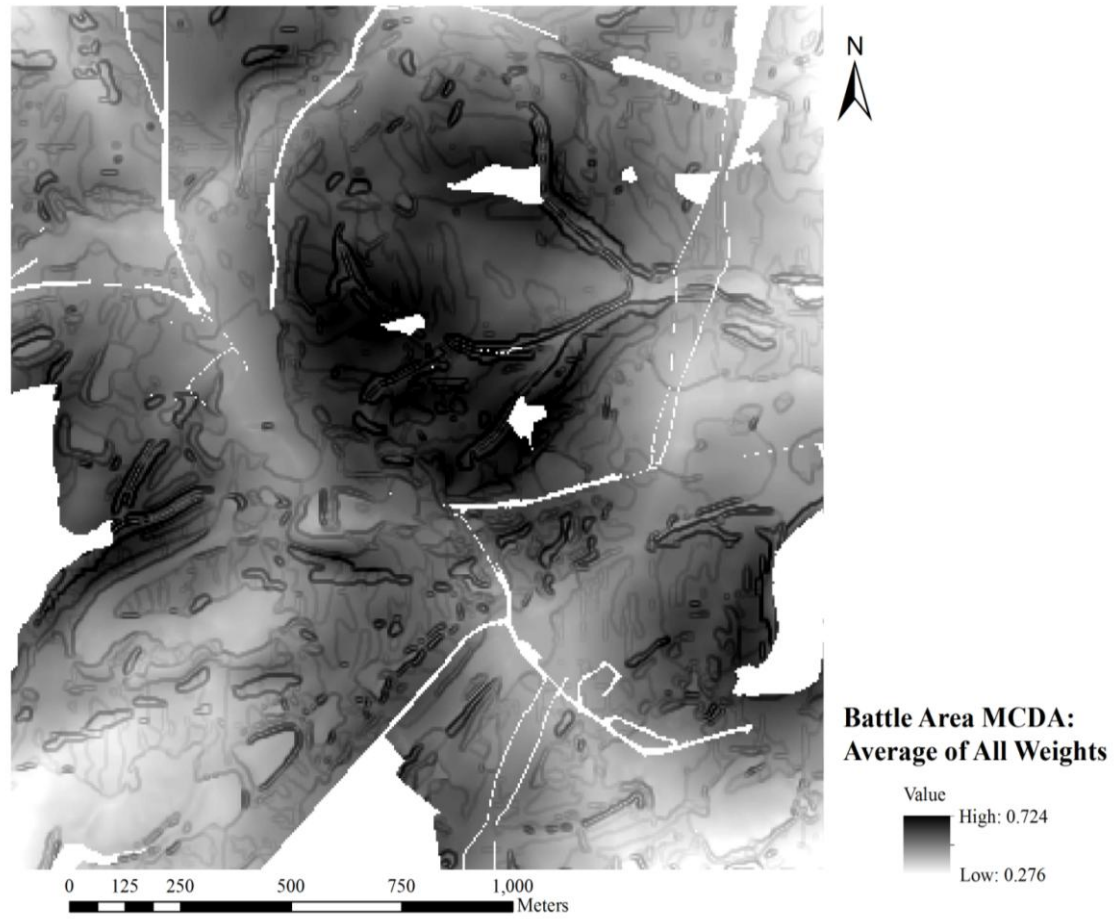
However, these results are based on one set of weights. By considering multiple sets of weights as applied in Section 7.1.3, a more comprehensive model for predicting the location of the battle may be generated.

Figure 7.6 presents the average of nine possible outcomes generated using the selected weights. This finding confirms the possibility of the alternative site, northeast of Battle Hill. Furthermore, this site is in close proximity to the location identified by Grehan and

<sup>34</sup> This map is based on the study area DEM and the estimated land use for 1066 (Figure 6.2) (ESHER, 2013; Stanfords Business Mapping, 2009).

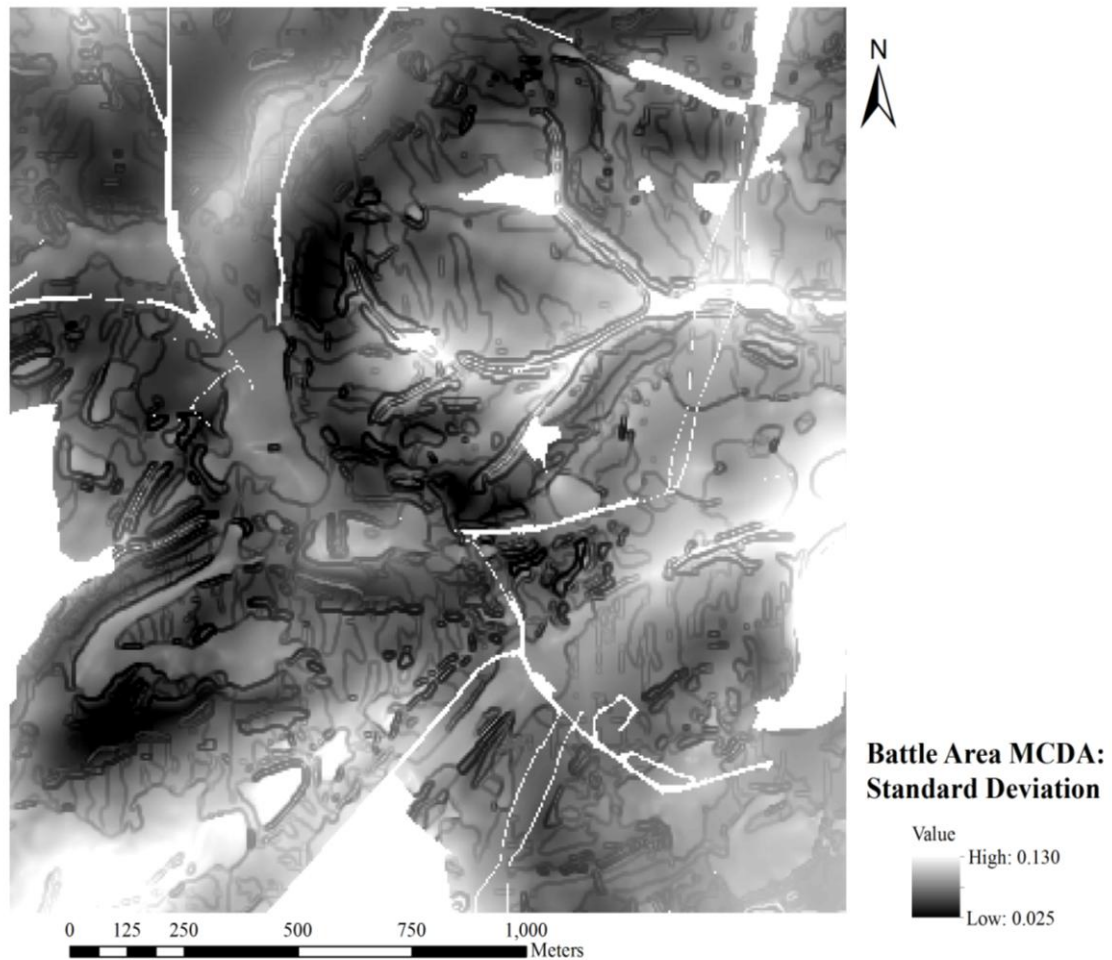


Mace in their book (2012, pp. 148-51). Figure 7.7, presents the analysis based on the standard deviation of the results per pixel, which supports the site identified above with low variations noted in that area.



**Figure 7.6: Battle Site in Battle Area – MCDA Average across all Weights at 5 m Resolution (c. 1066)<sup>35</sup>**

<sup>35</sup> This map is based on the study area DEM and the estimated land use for 1066 (Figure 6.2) (ESHER, 2013; Stanfords Business Mapping, 2009).



**Figure 7.7: Battle Site in Battle Area – MCDA Standard Deviation at 5 m Resolution (c. 1066)<sup>36</sup>**

### 7.1.5 Sources of Error in the Model

The findings presented above, which point to the existence of an alternative site just northeast of that traditionally believed to have hosted the conflict, Battle Hill where the Battle Abbey was constructed. Therefore, the question arises as to how accurate the model as depicted in Figures 7.5 – 7.7 may be. The model (Figures 7.5 – 7.7) could be incorrect due to a number of reasons. It was assumed the grey apple tree was on Caulbec

<sup>36</sup> This map is based on the study area DEM and the estimated land use for 1066 (Figure 6.2) (ESHER, 2013; Stanfords Business Mapping, 2009).



Hill and Hechelande was on Telham Hill. However, this assumption may have not been the case and as such these variables are abstract and not definitive. Another factor which could influence the results is the standardization of the criterion maps. In these models, the criterion maps were standardized with the linear transformation. However, as Malczewski discusses, there are additional standardization methods such as non-linear calculations which could have been employed. In these approaches, certain variables could have been enhanced or suppressed (Malczewski, 1999, p. 116). For example, if it were known at what angle medieval warhorses could not charge up, those areas could have been minimized in the model.<sup>37</sup> Therefore, with a different standardization method, there is a potential that different areas could have been selected as possible sites of the battle.

However, it is entirely possible that the model, which indicates the alternative site, is correct and the placement of Battle Abbey did not correspond with the actual battle site. The construction of Battle Abbey was not begun until several years after the battle in the early to middle 1070's. The first abbot did not arrive until 1076, ten years after the fact (Searle, 1974, pp. 21-3). Furthermore, in the *BA*, the monks debate the site of the abbey despite King William's firm insistence on the location of the battlefield. Specifically, according to the *BA*, the monks complained:

that the place where he [William] had decided to have the church built was on a hill (*colle*), and so dry of soil (*gleba*)<sup>38</sup>, and quite without springs (*aquarum*)<sup>39</sup>, and that for so great a construction a more likely place nearby should be substituted . . . [This decision also because of] the lack of water . . . [and] stone (*lapides*)<sup>40</sup> fit for building (p. 43-5).

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<sup>37</sup> The present author searched for evidence regarding the steepness of terrain which a line of horses could charge up but none was located.

<sup>38</sup> This term means soil however; it could also indicate church land, coal, or peat for fuel (*DMLBS*, IV, p. 1081-2).

<sup>39</sup> *Aquarum* suggests the presence or lack thereof of a watering hole (*DMLBS*, I, p. 113-4).

<sup>40</sup> Stone (*DMLBS*, V, pp. 1554-5).

However, William insisted on the site and promised a large amount of wine for the monks and plenty of stone from Normandy for construction. Although, in a twist of fate through a vision, the monks: “found such a supply of good stone (*lapidum*) that it was quite apparent that the Lord had laid up a hidden treasure of stone (*lapidem*) . . . for the predestined work” (*BA*, p. 45). However, given the political climate in the period following Hastings, it is uncertain as to how much of a priority the founding of the abbey was for William (Searle, 1974, pp. 21-3). Furthermore, as mentioned in Chapter 2, there is some debate about the authenticity of the documents on which the *BA* is based (Bradbury, 1998, p. 120). Therefore, the abbey may have been built on the site for a number of reasons as opposed to being built on the actual site of the battlefield.

## 7.2 Mapping Units

Having addressed research question 4, concerning the location of the battle, this part of the chapter moves to a consideration of the last research question in the study. Research question 5 asks “*how did physical landscape influence the development and outcome of the battle?*” As the first step in answering this question, Section 7.2 discusses how the various units which participated in the battle are represented cartographically. As part of this analysis, standard symbols are developed for cavalry, infantry and archers. The number of symbols to be presented in maps developed in Section 7.3 is then calculated for an army ranging from 4500 foot soldiers and 1500 cavalry up to 11000 foot soldiers and 3000 cavalry.

### 7.2.1 Cavalry

Based on a discussion with medieval military expert Dr. Stephen Morillo (October 2013), each mounted knight would take up a space approximately 2m wide by 3m deep, assuming a rider armed with a lance and carrying a shield in a military formation.<sup>41</sup>

When considering the size of the *conroi*, at around 20 to 25 men, then the size of the total formation could work out to approximately 12m by 12m. These dimensions would allow

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<sup>41</sup> These dimensions seem reasonable, given that according to a U.S. government website, horses alone are considered as 1.2m wide and 2m long (U.S. Department of Transportation, 2014).

the possibility of a unit six riders wide by four riders deep. In an army with approximately 1500 cavalry, 62 cells would be required to display this force cartographically. In a larger army, 125 cells would be required for an estimated cavalry force of 3000 riders. Thus, the cavalry would take up a large amount of space on the battlefield. At Hastings it is estimated that William's force consisted of approximately 2000 cavalry which would have equaled 83 cells.

### 7.2.2 Foot Soldiers and Archers

For cartographic purposes, the foot soldiers and archers are displayed together. Considering the tight infantry formations, each infantry soldier would have an area of approximately  $1\text{m}^2$ . This value can be partly determined from the shields. Specifically, the round shields which many soldiers would have been using were approximately 1m wide (Abels, 1991, p. 149). If it is assumed that the foot-soldiers were between ten to 12 ranks deep then 144 men on average would fit into a 12m by 12m box (Lawson, 2003, p. 143; Morillo, 1996, p. xxv). This value is very similar to the figure reported for cavalry. Based upon these dimensions, an estimated army of 4500 foot soldiers would take 31 raster cells to map out. In a large army of around 11000, 76 cells would be required for a scaled display. At Hastings it is estimated the English had a force of 7500 while the Normans had 5500 which would have been 52 and 38 cells respectively.

## 7.3 Stages of the Battle

Based upon the previous discussions regarding location and unit mapping, the battle itself can be modeled cartographically. The most detailed existing presentation of the stages to date is in the introduction to Morillo's book on the battle (1996, pp. xxii-xxxii). However, Morillo did not elaborate on the stages of the battle as will be examined here.

To undertake this task, three maps, Figure 7.8 to 7.10, were developed by the author to depict the overall landscape of the battle. Figure 7.8 is a slope map which graphically depicts the topography of the battleground in degrees. Figure 7.9 depicts the Pennock land classification. This map is useful in identifying crests of ridges where Harold could have arranged his men. Figure 7.10 indicates the local topographical wetness index

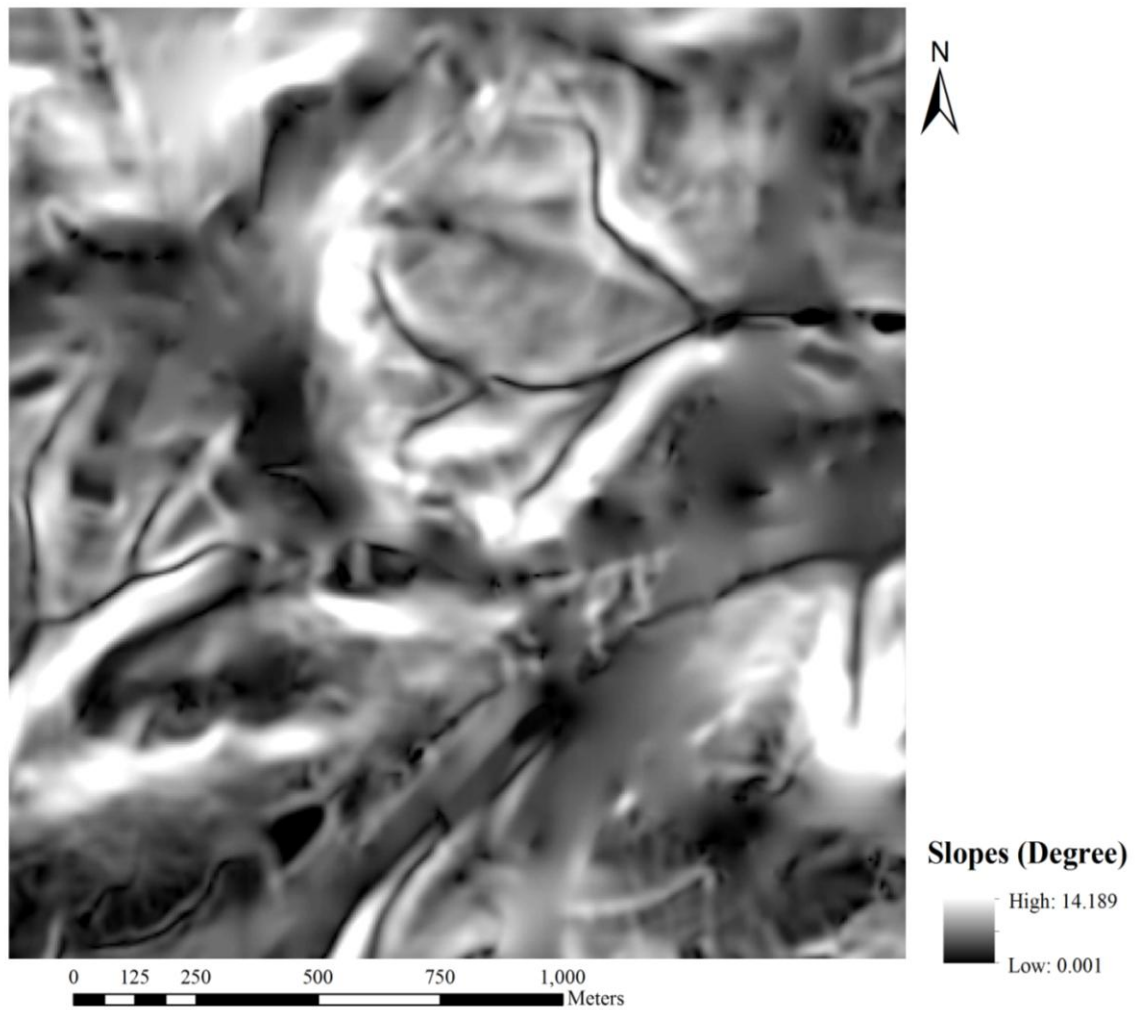
(TWI).<sup>42</sup> This figure, based on the local drainage network, suggests areas which would have been wetter than others. Given the length of the battle and presence of water in the area (Figures 5.13 and 6.11),<sup>43</sup> identifying which areas would have been more challenging to traverse will be useful in understanding the interaction between the battle and the landscape.

In the following sub-sections, with reference to the figures developed above, the various stages of the battle will be presented each in turn. The discussion begins with the arrival of the two armies.

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<sup>42</sup> The TWI is derived in accordance with the following equation:  $\ln(a/\tan\beta)$  “where  $\tan\beta$  is the local slope of the ground surface and  $a$  [m] is the upslope area per unit contour length” (Sørensen & Seibert, 2007, p. 80).

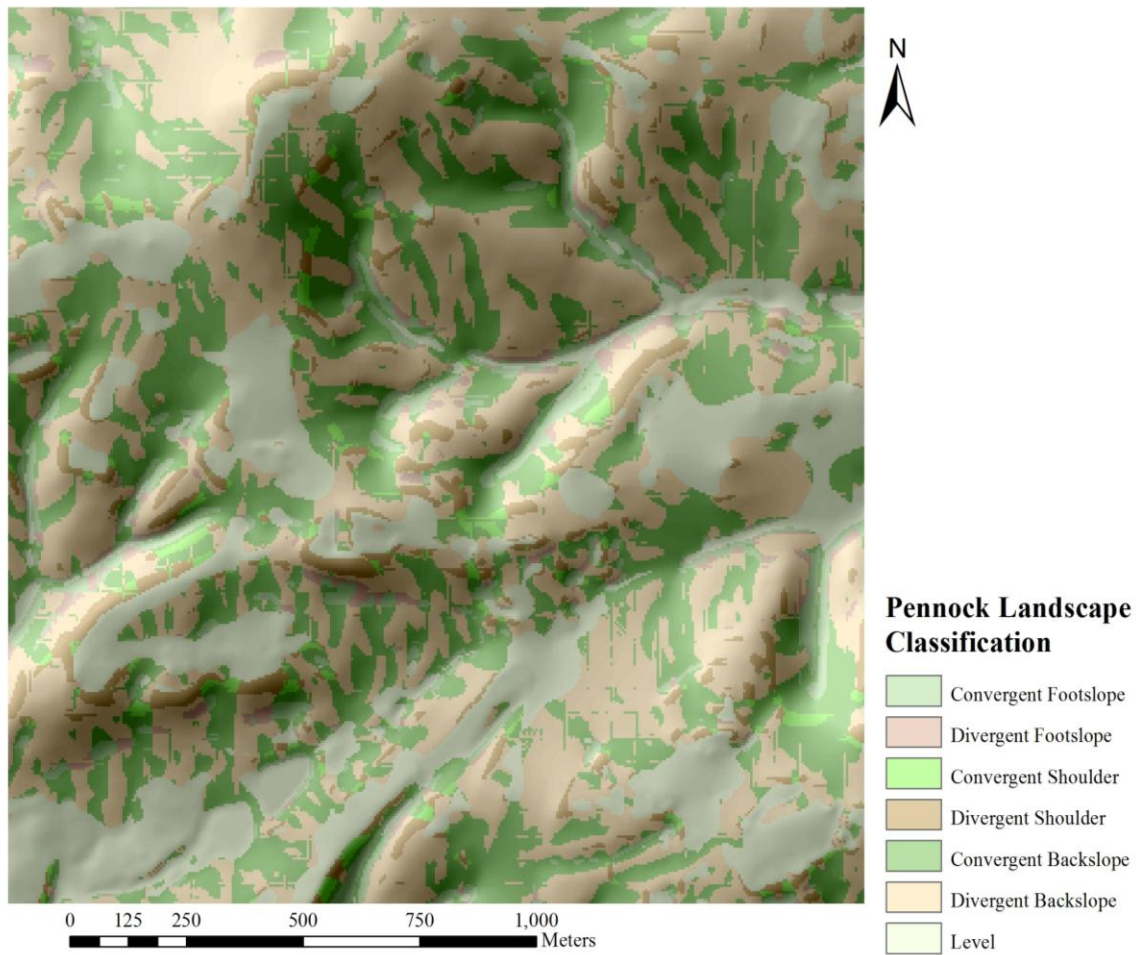
<sup>43</sup> Based off of Figure 5.25 in Brady and Weil’s book, the soil water content would likely have been between 20 per cent (wilting point) and 36 per cent (field capacity) (2004, p. 157).



**Figure 7.8: Battle Area Slope Map in Degrees at 5 m Resolution<sup>44</sup>**

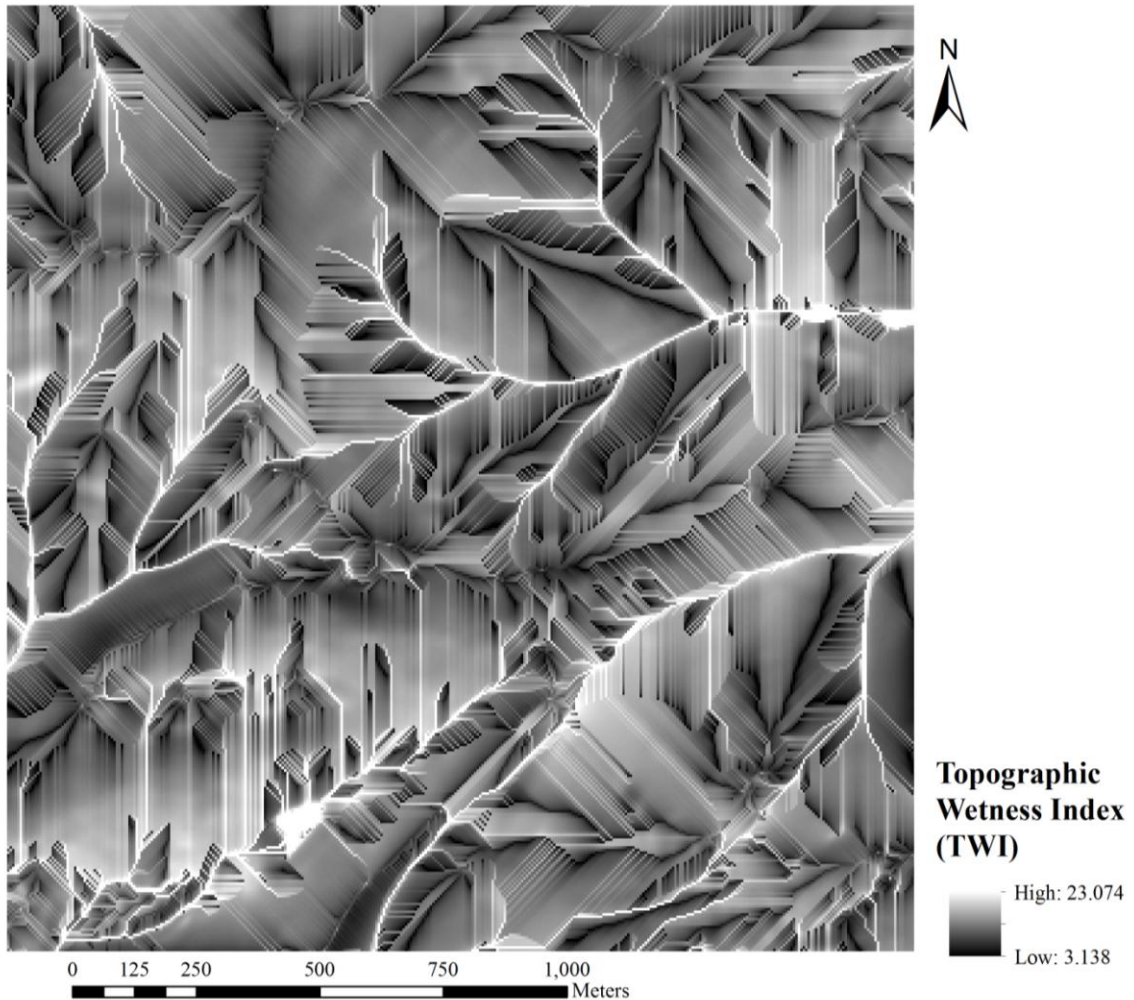
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<sup>44</sup> This map was derived from the Battle area DEM (Stanfords Business Mapping, 2009).



**Figure 7.9: Battle Area Pennock Landscape Classification with Shaded Relief at 5 m Resolution<sup>45</sup>**

<sup>45</sup> This map was derived from the Battle area DEM (Stanfords Business Mapping, 2009).



**Figure 7.10: Battle Area Topographic Wetness Index at 5 m Resolution<sup>46</sup>**

### 7.3.1 Arrival and Negotiations

The arrival of the two forces was one of the most important events in a medieval battle as at this point the commander “had a greater ability to affect the outcome of battle than he did once the armies closed” (Halsall, 2003, p. 192). Marching along the local roads,<sup>47</sup>

<sup>46</sup> This map was derived from the Battle area DEM (Stanfords Business Mapping, 2009).

<sup>47</sup> Both sides would have likely followed the local roads. The local road network was discussed from Yeakell and Gardner’s map (1783) because “[f]ew new roads were created between Saxon times and the turnpike and ‘enclosure’ roads of the eighteenth century” (Hoskins, 1977, p. 242). Therefore, it is assumed that land use changes permitting, the roads of 1783 were in existence in the eleventh century (Figure 7.12).

once one side recognized the enemy force, it would begin to maneuver into the strongest battle position possible (*BT*, Plate 56-7). In the case of the Battle of Hastings, the English cautiously chose a location which was on higher ground and which had a steep slope.

*WP* notes this point in detail by claiming the English:

took their stand on higher ground, on a hill (*montem*) near to the wood through which they had come. At once dismounting from their horses, they lined up all on foot in a dense formation. Undeterred by the roughness (*asperitate*) of the ground, the duke with his men climbed slowly up the steep slope (*ardua cliui sensim ascendit*) (*WP*, p. 127-9).

A similar comment is located in the *CHP* where Harold: “mounted the hill (*Ascendit montem*), defended his flanks with noblemen, [and] planted his standard<sup>48</sup> on the summit (*summo montis*)” (p. 23). The *CHP* also positions the English formation throughout the account to a densely wooded area (*CHP*, pp. 27 and 33). *JW* indicates the location was narrow (*arto*) however, this claim is not supported in the other sources (p. 605).

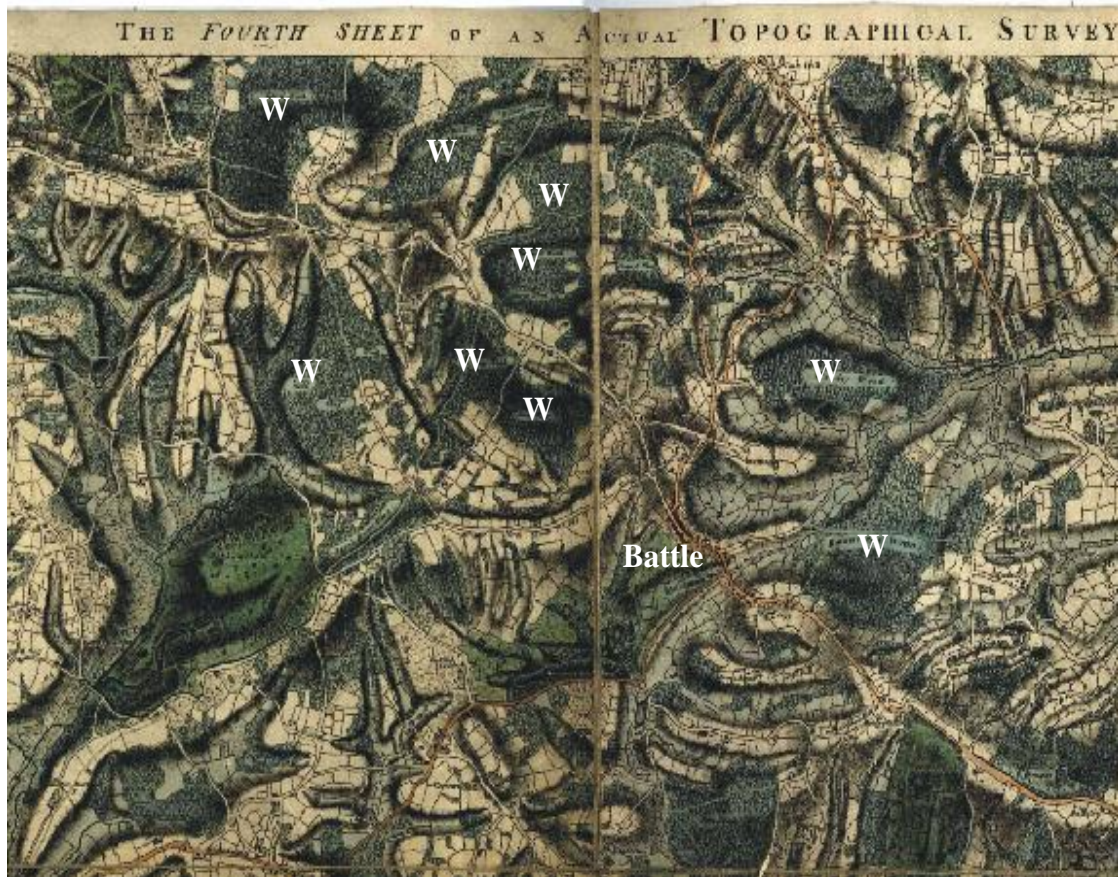
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<sup>48</sup> Halsall discusses the importance of standards and as a location of intense fighting (2003, pp. 199-200). For Harold’s standard, see *BT* Plate, 71; while William’s is displayed at Plate 53 and 69 for “the sacred cross-banner”.





**Figure 7.11: Norman Advance over Hill**  
**Detail of the Bayeux Tapestry – 11<sup>th</sup> Century (BT, Plates 56-7)**



**Figure 7.12: Part of the Yeakell and Gardner Map of Sussex (1783) © West Sussex Record Office**

Based upon these descriptions, Harold then would have been looking for a location which in topographical terms, was on higher ground, protected by steep slopes and in close proximity to extensive woodland.<sup>49</sup> Based upon the literature and the MCDA model for the Hastings area, there were several locations which could have met these criteria. Further developing the methodology presented in Knowles et al.'s study (2008), the local viewsheds for both Harold and William were calculated for this study and presented in

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<sup>49</sup> *WP* and the *CHP* do not indicate how close the woods through which Harold came were. They could be at the site or they could be a short yet visible distance away. Most historians have interpreted the documents as implying the English came through the woods directly onto the battlefield. However, these chroniclers were not present and thus had to rely on eye-witnesses who could have exaggerated events. For example the eye-witnesses could have seen the English come through the woods just north of Battle (*W*'s in Figure 7.12). Likewise the chroniclers could have exaggerated the events for their own audiences.

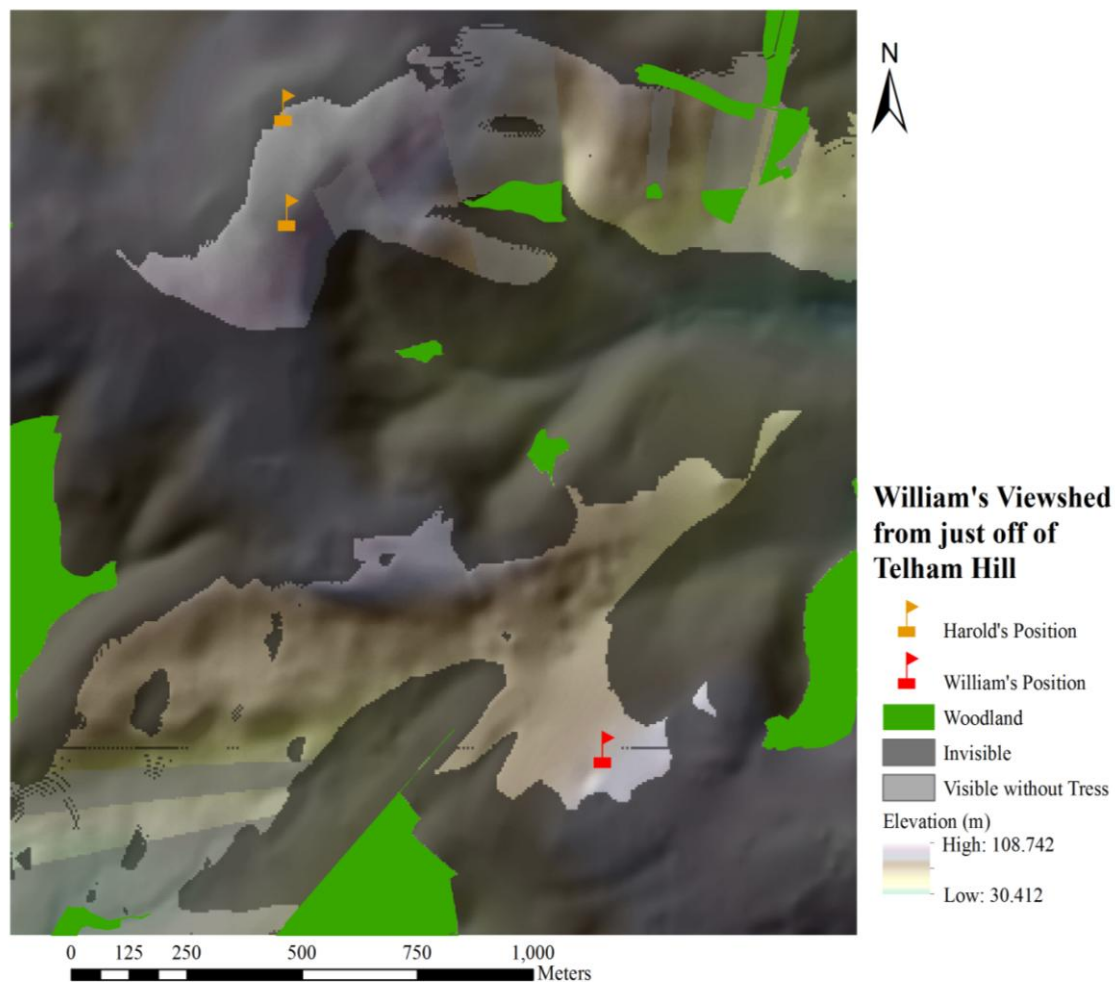
Figures 7.13 to 7.15. Each map depicts what was visible to each commander based upon the local topography as well as the local topography with trees.<sup>50</sup>

From this analysis, two potential paths to the battle emerge. The first path follows the road directly to Battle Hill, the traditional site, whereas the second route deviates from the roads and travels down through the valley to the alternate site – Caulbec Hill – where the grey apple tree stood (Bradbury, 1998, p. 132). The second route is supported by the MCDA analysis of Battle which indicated the battle site was in fact located near Caulbec Hill as opposed to Battle Hill. This site is visible from the majority of the viewsheds as calculated in Figures 7.13 and 7.14.

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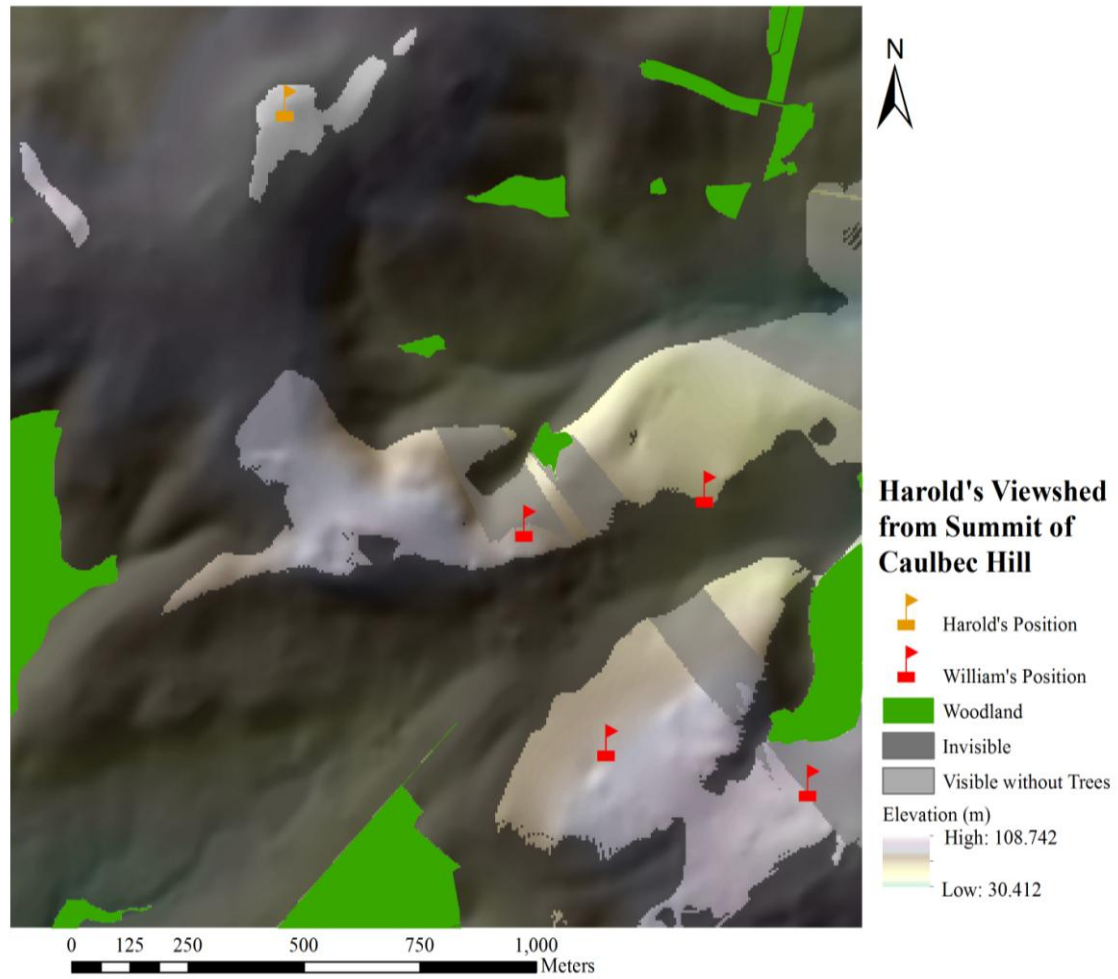
<sup>50</sup> Knowles et al.'s study mapped what was visible with just the topography and only considered trees in one map (2008, pp. 257-9). In this study, the viewsheds were calculated in consideration of topography and topography and trees at a height of 35m. Initially, a measurement of 11 m was considered (Rackham, 1980, pp. 146-7). However, that measurement does not include the full canopy. Therefore, a height of 35m was selected because that is the estimated height of an old growth forest based upon one in Poland at Białowieża (Read & Frater, 1999, p. 26). Furthermore, that value is for the tallest trees in the stand from the base to the top of the tree canopy.





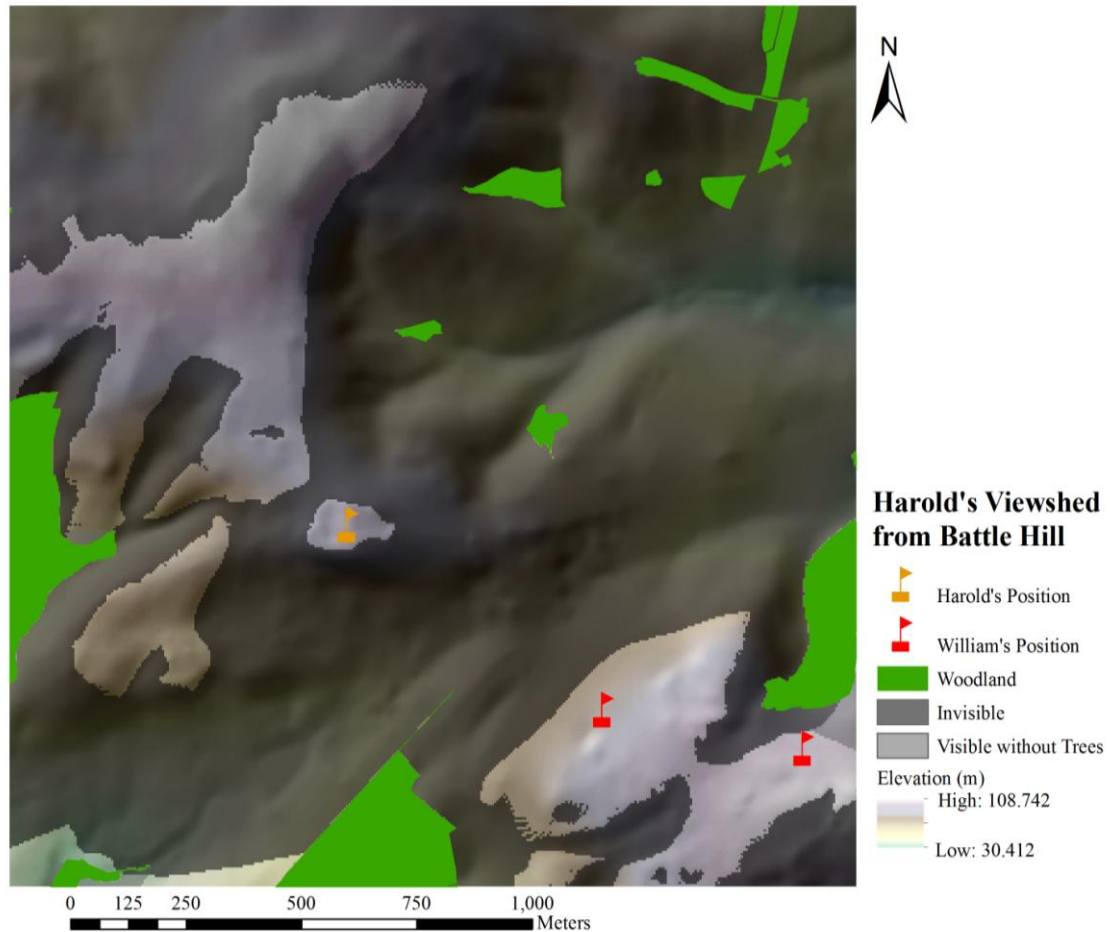
**Figure 7.13: William's Viewshed from just off of Telham Hill at 5 m Resolution (c. 1066)<sup>51</sup>**

<sup>51</sup> This map is based on the study area DEM and the estimated land use for 1066 (ESHER, 2013; Stanfords Business Mapping, 2009).



**Figure 7.14: Harold's Viewshed from Summit of Caulbec Hill at 5 m Resolution (c. 1066)<sup>52</sup>**

<sup>52</sup> This map is based on the study area DEM and the estimated land use for 1066 (ESHER, 2013; Stanfords Business Mapping, 2009).



**Figure 7.15: Harold's Viewshed from Battle Hill at 5 m Resolution (c. 1066)<sup>53</sup>**

The English strategy was simple: surprise the Normans, as they had the Norwegians, and defeat them (Chapter 4) (Douglas, 1964, p. 197). By dismounting, the English were planning to “stand and fight . . . [and this stance was one of the] mutually understood cultural norms of early medieval warfare” (Lavelle, 2010, p. 130). Based upon previous studies, the English army would likely have been organized by shire, for example, with the forces of Kent or Sussex together.<sup>54</sup> Thus, following the evidence presented in the

<sup>53</sup> This map is based on the study area DEM and the estimated land use for 1066 (ESHER, 2013; Stanfords Business Mapping, 2009).

<sup>54</sup> It would be highly speculative to estimate which shires fought where in the army.

discussion in Chapters 2 and 4, the battle formations would have corresponded to the English military's existing organization and mobilization at the time.

William on the other hand came from the south-east along the main road which began just to the north of Hastings. At the bottom of the hill (Figure 7.16), the Normans were forming. According to *WP*, William:

placed foot-soldiers in front, armed with arrows and cross-bows; likewise foot-soldiers in the second rank, but more powerful and wearing hauberks; finally the squadrons of mounted knights, in the middle of which he himself rode with the strongest force, so that he could direct operations on all sides with hand and voice (*WP*, p. 127-9).

*WP* further indicates that William's force came from Aquitaine, Brittany, Maine, and the Île-de-France. In addition, the Norman, Roger of Beaumont's son Robert, commanded a battalion on the right (*WP*, p. 131).

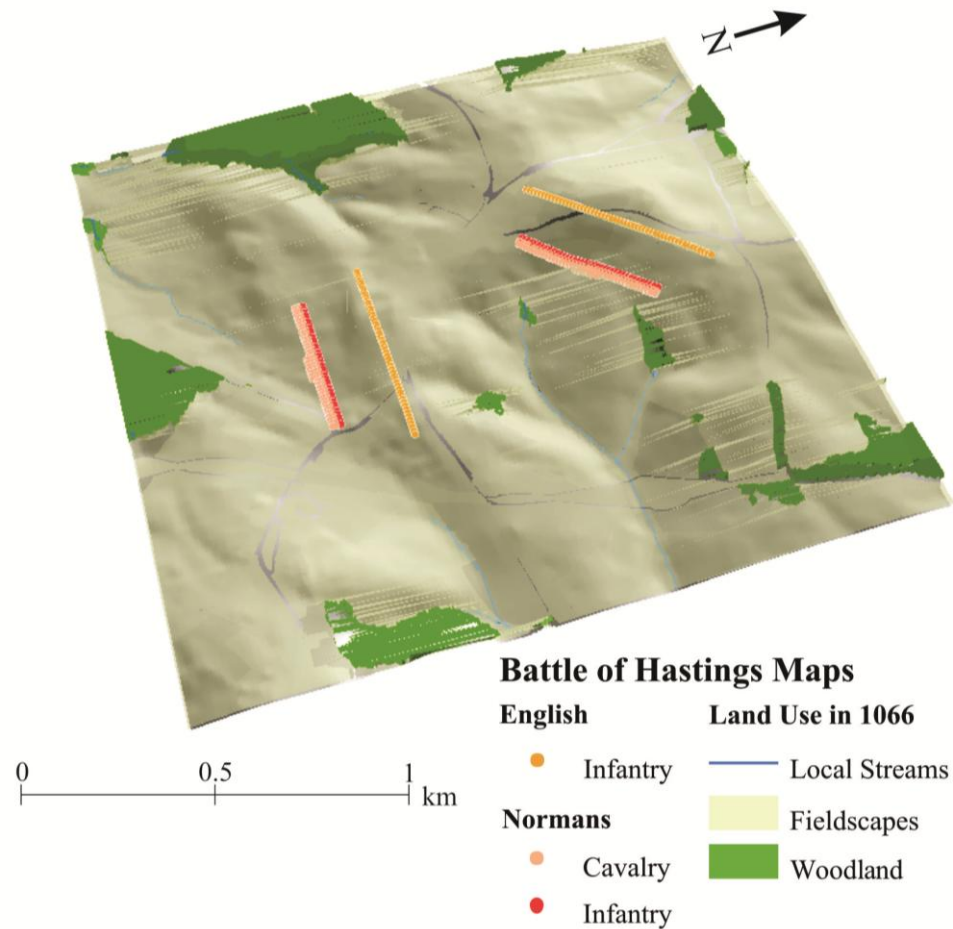
In terms of lines of formation on attack, according to the *CHP*, "[t]he French attacked the left and the Bretons the right while the Duke with his Normans [fought] in the centre" (p. 25).<sup>55</sup> However, according to *WP*, the Bretons were on the left (p. 129). Most historians believe that the Normans were in the centre, the French were on the right and the Bretons on the left (Lawson, 2003, pp. 209-10). Nonetheless all agree that the setup of the battle was such that, if William wanted to be King of England, he would have to fight up the hill to defeat Harold.

Figure 7.16 depicts a cartographic reconstruction of the battle in a series of oblique perspective maps based upon the Figure 6.2 land use map. Additionally, both battle sites are mapped with the traditional location on the left and the alternative site as determined by the author on the right. With respect to the combatants, the English are presented in orange while the Normans are dark red for the infantry and light red for the cavalry. The units have been scaled to 12 m by 12 m plots as presented above. The English are

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<sup>55</sup>This comment appears to be written from an English perspective on the battlefield.

commencing the battle with 52 foot soldier units or 7488 men while the Normans have 38 foot soldier units and 83 cavalry units or 7464 men.



**Figure 7.16: Arrival and Formations at Two Possible Battle Sites<sup>56</sup>**

### 7.3.2 The Battle Begins

The sounds of trumpets announced the start to the battle at the third hour of the day (*CHP*, p. 23; *GND* p. 169; *JW*, p. 605; *OV*, p. 173; *RR*, p. 181-3; *WP*, p. 129). Following the trumpets:

<sup>56</sup> This map is based on the study area DEM and the estimated land use for 1066 (ESHER, 2013; Stanfords Business Mapping, 2009).



the Norman foot-soldiers closed to attack the English, killing and maiming many with their missiles. The English for their part resisted bravely each one by any means he could devise. They threw javelins and missiles of various kinds, murderous axes and stones tied to sticks (*WP*, p. 129; *BT*, Plate 62-3; Figure 7.18).

In battle, as one historian has noted, “warriors would be trying to jab or cut over their shields . . . with little room to do much else” (Halsall, 2003, p. 199). Halsall further explains that there would have been relatively fewer casualties at early stages of the battle, as only a few soldiers would have fought in the engagement while the rest of the army would have remained supportively on the sidelines (2003, p. 199).

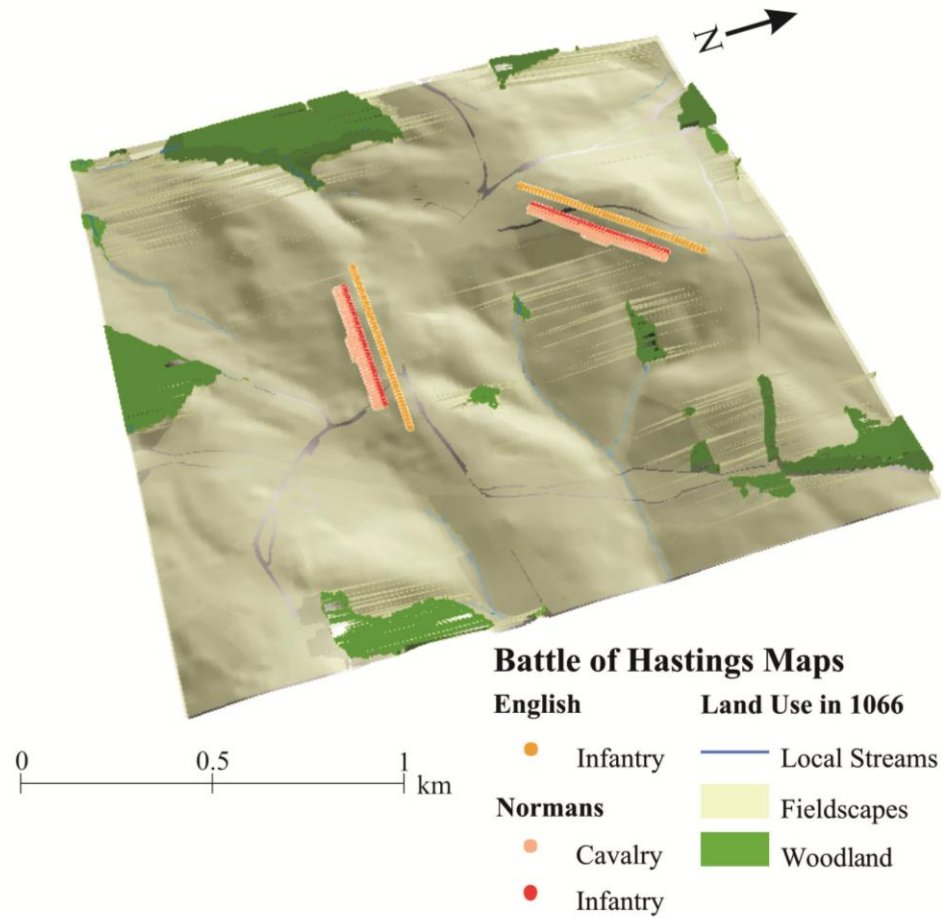
After failing to break through the English ranks, the Norman foot soldiers retreated to allow for the second attack of the day by William’s cavalry (*BT*, Plate 62-3). The retreating foot soldiers would have at this point likely followed behind the cavalry. However, none of these assaults were able to force the English off the hill. In effect:

The English were greatly helped by the advantage of the higher ground (*superioris loci*), which they held in serried ranks without sallying forward, and also by their great numbers and densely-packed mass, and moreover by their weapons of war, which easily penetrated shields and other protections (*WP*, p. 129).

This standoff marked the end of the first phase of the battle. This phase of the battle is presented in Figure 7.18 which also models modest reductions in troop strength at two units per army or 288 men. The next section describes the critical phase associated with the loss of the William’s Breton contingent.



**Figure 7.17: Norman Knights attacking English Foot Soldiers**  
**Detail of the Bayeux Tapestry – 11<sup>th</sup> Century (BT, Plates 62-3)**



**Figure 7.18: The Battle Begins<sup>57</sup>**

### 7.3.3 The Breton Crisis

As is suggested earlier in the thesis (Chapters 1, 2 and 4), William's cavalry were an important part of his army. With William's cavalry unable to break through Harold's lines, the English would likely have felt a tremendous boost of confidence. The Normans:

terrified by this ferocity, both the foot-soldiers and the Breton knights and other auxiliaries on the left wing turned tail; almost the whole of the duke's battle line gave way . . . The Normans believed that their duke and

<sup>57</sup> This map is based on the study area DEM and the estimated land use for 1066 (ESHER, 2013; Stanfords Business Mapping, 2009).

lord had fallen, so it was not too shameful to give way to flight (*WP*, p. 129).

As *WP* indicated, the Breton knights and other auxiliaries believing William had been killed fled from the battlefield. With the Bretons and other troops in full flight, the situation provided the English with an opportunity to attack. In fact *WP* records that William could see “a great part of the opposing force springing forward to pursue his men” (p. 131). It is possible that this attack could have been led by Gyrth and or Leofwine, Harold’s brothers (*BT*, Plate 64; *CHP*, p. 29; Figure 7.21). In the lead up to the battle, *OV* has Gyrth indicating in the text that Harold should allow him to attack William. Furthermore, as *OV* indicates, such a reprieve would have allowed Harold to rest following the victory over Hardrada (*OV*, pp. 171-3). The *GR* also supports this contention (p. 453).

During the English advance, a number of William’s men continued to flee.<sup>58</sup> However, the *BT* suggests, Gyrth and or Leofwine were either injured or killed by this point (*BT*, Plate 64), and by the time the English realized their leadership was gone, it was probably too late to recall the attackers. It was also at this point that William began rallying his men to repel the English attack (*BT*, Plate 68-9). According to *WP*, William:

cried, ‘Look at me. I am alive, and with God’s help I will conquer’ . . . [and led his men to defeat those] who had pursued them and destroyed them in a moment, so that not a single one survived (*WP*, p. 131).<sup>59</sup>

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<sup>58</sup> According to Halsall, “the death of a commander could dispirit the whole army” (2003, p. 199).

<sup>59</sup> *OV* presents a similar rallying cry: “Look at me: I am alive and with the aid of God I will gain the victory” (p. 175).



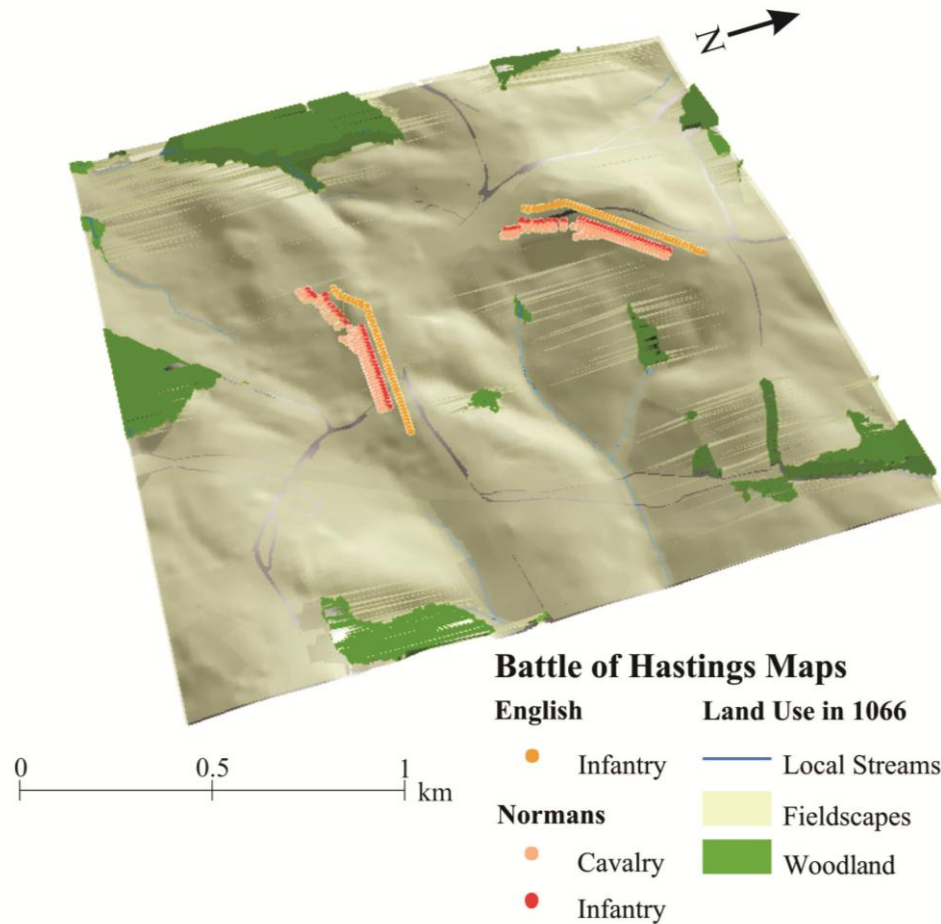
**Figure 7.19: Battle around Hill in Bayeux Tapestry**  
**Detail of the Bayeux Tapestry – 11<sup>th</sup> Century (BT, Plates 66-7)**



It is generally believed by historians that it was at this point in the battle that the conflict turned in favour of the Normans as depicted in the *BT* plates 66-7. It is this point of the battle that was taken into consideration in the mapping exercise (see Figure 7.21) by estimating an English loss of six units or 864 men. The Normans, on the other hand, are presented as having lost four foot soldier units and ten cavalry units or 816 men.



**Figure 7.20: William revealing his face to show he is alive**  
**Detail of the Bayeux Tapestry – 11<sup>th</sup> Century (*BT*, Plates 68-9)**



**Figure 7.21: The Breton Crisis<sup>60</sup>**

#### 7.3.4 Noonday and Assessment of Battle

Following the Breton crisis, many historians have assumed the battle took a pause and soldiers were fed and tended to their wounds. For the Normans, the near collapse of their army would have been a concern. To their advantage, however, they would also have acquired a sense of English tactics and strategy, and were beginning to better understand the topography and the strength of the English position. For the English, the likely loss of one or both of Harold's brothers would have been devastating. However, given their strong position, they would have likely felt they could maintain their position.

<sup>60</sup> This map is based on the study area DEM and the estimated land use for 1066 (ESHER, 2013; Stanfords Business Mapping, 2009).

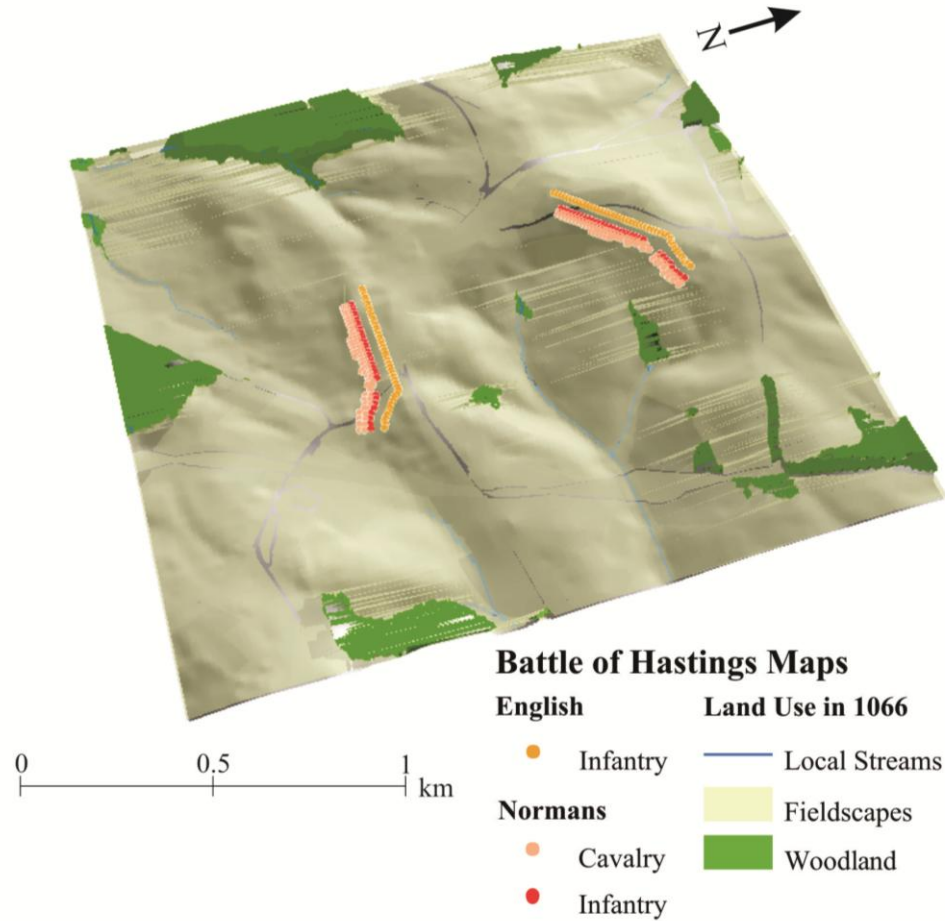
### 7.3.5 Afternoon Battle

In the afternoon, the Normans renewed their attack on main English line with foot soldiers and cavalry. The English on the other hand continued their strategy of maintaining their position with their dense infantry formations along the ridge. It is at this point in the account that *WP* and other sources (*BR*, p. 32a; *GR*, p. 455; *OV*, p. 175) focus on the storied Norman strategy of the feigned retreat, as depicted in Figure 7.22. *WP* suggests this tactic was employed because the Normans realized they could not defeat the English by military force and thus would try a form of trickery instead (*WP*, p. 133). The feigned retreat was a simple tactic. The Normans would attack, then flee, while the English would follow only to be crushed when the Normans returned. *HA* suggests the feigned retreats were fought over a ditch thus making the fighting more difficult (pp. 393-5).<sup>61</sup> *WP* maintains this tactic was employed twice on the battlefield (p. 133) while recent commentators suggest the feigned retreats occurred for most of the afternoon (Morillo, 1996, pp. xxviii-xxix).

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<sup>61</sup> If this claim were true, it would suggest the greater likelihood of the alternative site at Caulbec Hill as here there are numerous places where the ground could be considered as difficult.





**Figure 7.22: The Feigned Retreats<sup>62</sup>**

Following the feigned retreats:

a combat of an unusual kind began,<sup>63</sup> with one side attacking in different ways and the other standing firmly as if fixed to the ground. The English grew weaker . . . confessing their guilt by their defeat . . . the dead by falling seemed to move more than the living. It was not possible for the lightly wounded to escape (*WP*, p. 133).

<sup>62</sup> This map is based on the study area DEM and the estimated land use for 1066 (ESHER, 2013; Stanfords Business Mapping, 2009).

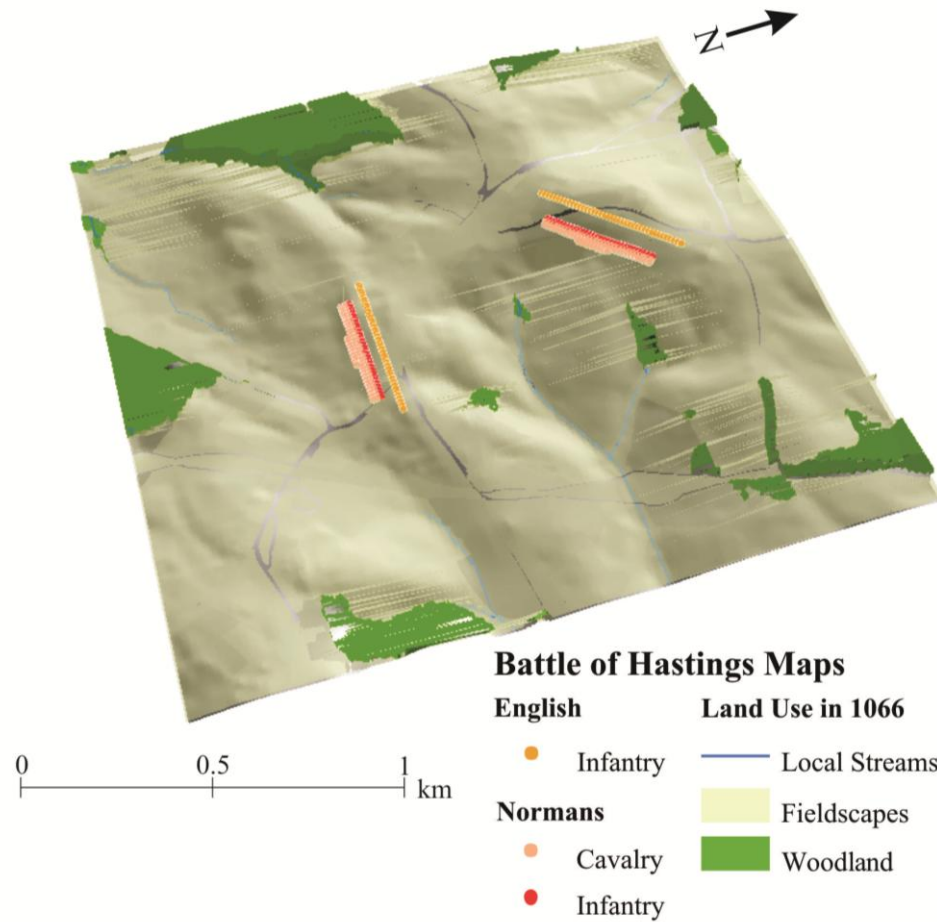
<sup>63</sup> Morillo discusses how Hastings was not a typical medieval battle (1990; 1996, p. 219).

It is believed this part of the battle continued on and off until the late afternoon.<sup>64</sup> *WP* supports the theory “that [the] battle . . . [consisted] of short bouts of close fighting between longer periods of rest and recuperation, and perhaps skirmishes and exchanges of missiles” (Halsall, 2003, p. 204). Figure 7.22 estimates the likely impact of the losses at this stage of the battle with a reduction in the English army of four units or 576 men and a Norman loss of two foot soldier units and four cavalry units or 384 men (Figure 7.22).

As the battle progressed, William would have been becoming concerned regarding the direction the conflict was taking. Throughout the battle, English reinforcements would have been arriving from the surrounding areas. William would probably have realized that to defeat Harold he would have to do it within the shortest time span possible; certainly no more than a day. In an attempt to attain ultimate victory, William attacked with all of his remaining units. This attack (*BT*, Plate 69; Figure 7.23) occurred late in the day around dusk. The Norman archers were ordered “not to shoot their arrows directly at the enemy, but rather into the air, so that the arrows might blind” (*HA*, p. 395) them. It is believed that during this attack, one of the most iconic events of the battle took place, the death of Harold.

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<sup>64</sup> In this part of the description, *WP* discusses how William was willing to have single combat against Harold (p. 135-7).



**Figure 7.23: Final Attack**<sup>65</sup>

### 7.3.6 Death of Harold

It is believed that Harold was killed sometime during the time of the final attack in the battle. However, the manner of his death is open to speculation. According to the *BA*, Harold was killed by a “chance blow” (p. 39). *HA* suggests he was wounded by an arrow in the eye and then killed along with his brothers by Norman knights (p. 395). This document also links the death of Harold to the capture of his banner (*HA*, p. 395). The *CHP* provides a detailed description of Harold’s death by four knights including William (p. 33). According to the *CHP*,

<sup>65</sup> This map is based on the study area DEM and the estimated land use for 1066 (ESHER, 2013; Stanfords Business Mapping, 2009).

The first of the four [knights], piercing the king's shield and chest with his lance, drenched the ground with a gushing stream of blood. The second with his sword cut off his head below the protection of his helm. The third liquefied his entrails with his spear. And the fourth cut off his thigh and carried it some distance away (p. 33).

The time of Harold's death is reported by *JW* (p. 605) and in the *RR* (p. 190) as well as the *GR* (p. 455) as occurring late in the battle at dusk.<sup>66</sup> The most famous depiction of Harold's death is illustrated in the *BT* which shows Harold being struck by an arrow in the eye and then killed (Plate 71-2).<sup>67</sup> However, there are no firsthand accounts pertaining to the exact nature of Harold's death. Furthermore, Davis & Chibnall suggest in their notes on *WP* that the Normans who killed Harold may not have survived themselves (1998, p. 136). Thus, it will never be certain as to when or how precisely Harold died during the battle.

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<sup>66</sup> The *GND* and *OV* have Harold being killed early on (*GND*, p. 169; *OV*, p. 177). Wace has Harold being shot in the eye before feigned retreat (*RR*, p. 183).

<sup>67</sup> One commentator has suggested that Harold being struck in the eye was figurative and based upon the bible (Bernstein, 1982, pp. 60-4).

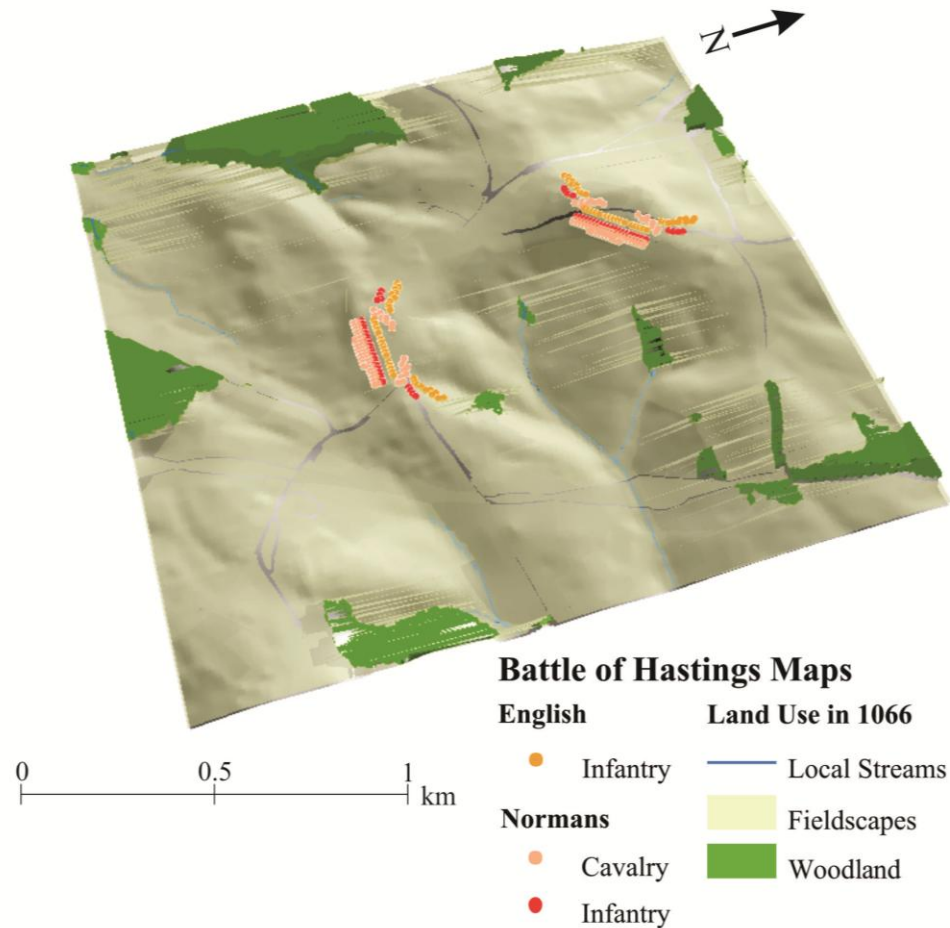


**Figure 7.24: Death of Harold**

**Detail of the Bayeux Tapestry – 11<sup>th</sup> Century (BT, Plates 71-2)**

### 7.3.7 The Last Stand and English Flight

Knowledge of Harold's death would have spread throughout both armies. *WP* claims that at this point in the battle, the English realized they were defeated while the Normans did not appear weakened and were fighting with more energy than ever before (*WP*, p. 137). *WP* maintains that William desired a complete victory and did not want to spare anyone left on the battlefield (*WP*, p. 137). Thus, it is at this point that the majority of the English line collapsed and fled (Figure 7.25). Referring to William and another northern French ally, the *CHP* states "they clear the battlefield of English troops . . . Just as a wood, when the axe is applied, is cropped to pieces, so the English forest was reduced to nothing" (p. 33).



**Figure 7.25: Normans Breakthrough and English Collapse<sup>68</sup>**

The English fled in any way they could have along the local roads (*vias*)<sup>69</sup> or through the fields (*avia*)<sup>70</sup> (WP, p. 137; BT, Plate 73; OV, p. 177; RR, p. 190). As they did so, they were pursued by Norman knights “putting the last touches to the victory” (WP, p. 137-9). However, the fleeing English did make one last stand at “a broken rampart and labyrinth of ditches (*praerupti valli et frequentium fossarum*)” (WP, p. 139). WP suggests in this

<sup>68</sup> This map is based on the study area DEM and the estimated land use for 1066 (ESHER, 2013; Stanfords Business Mapping, 2009).

<sup>69</sup> *Vias* is a road or pathway. However it can also mean a method, possibility or route of travel (DMLBS, XVII, p. 3658-9).

<sup>70</sup> This term indicates something is “out of the way” from roads (DMLBS, I, p. 171). However, it should be noted that the spelling is the same as the Latin word for grandmother (DMLBS, I, 170).

skirmish, the English fought with the aid of reinforcements arriving late in the day. *WP* contends William insisted on pursuit (p. 139), and it is believed that this part of the battle occurred in the area which was named the *Malfosse* (*BA*, p. 39). This area is likely to have been in one of the many ditches to the northwest of the main battle site or west of the alternative site at Caulbec Hill. For the Normans, *WP* claims that “their valour was of no avail on such unfavourable ground (*adversitate loci*)” (p. 139). It is believed the fighting ended around dusk or the early evening (*BR*, p. 32a; *GND*, 169; *JW*, p.605). In the end, “only darkness and flight through the thickets and coverts of the dense forest saved the defeated English” (*CHP*, pp. 33-5). In Figure 7.25, depicting the combined assault and break through, English losses are estimated at four units (576 men) while the Normans are estimated as losing another two foot soldier units and four cavalry units (384 men).

## 7.4 Battlefield Interpretation

Given their importance to the conduct and possible outcome of the battle, in this section, the topography and condition of the battlefield are further explored. Based on the field capacity and the wilting point<sup>71</sup> of the local soils (see note 43) (Brady & Weil, 2004, p. 157), it is estimated the soil water content would have been between the two extremes (the value in between is just less than 30 per cent). Another factor to consider is the TWI, as presented in Figure 7.10, which indicates where the water would flow based upon the local topography. Additionally, with the repeated movement of large bodies of soldiers and horses over the landscape, the surface vegetation would have declined. This loss of vegetation would have added to the loss of surface stability as soils with less plant material are less stable (Brady & Weil, 2004, pp. 120-1).<sup>72</sup> When these factors are

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<sup>71</sup> Field capacity is “[t]he percentage of water remaining in a soil 2 or 3 days after its having been saturated and after free drainage has practically ceased” (Brady & Weil, 2004, p. 575). The wilting point on the other hand is “[t]he moisture content of soil, on an oven-dry basis, at which plants wilt and fail to recover their turgidity when placed in a dark, humid atmosphere” (Brady & Weil, 2004, p. 591).

<sup>72</sup> See Figure 4.29 in Brady and Weil’s book on soils. The figure suggests that without vegetation the soil structure is less stable (Brady & Weil, 2004, pp. 120-1).



combined, good conditions for localized instances of liquification or liquefaction to occur would exist. In these conditions, the battlefield would have quickly turned into a mud field (Brady & Weil, 2004, p. 128; Summerfield, 1991, p. 167). As one group of military geographers have claimed, “mud has been a formidable element in every prolonged military campaign, and sometimes it is the decisive factor in a military operation” (Winters, Galloway Jr., Reynolds, & Rhyne, 1998, p. 33). Thus, in combining the presence and downward flow of water (TWI) with a decline in the vegetation surface, the landscape would have become difficult, particularly in or near areas from Figures 7.8 and 7.10 with higher values as well as those regularly traversed during the battle.

## 7.5 Conclusion

In this chapter, a number of geographic discussions concerning the Battle of Hastings were developed as part of an attempt to address research question 4, an exploration of the location of the battle. In the first section of this chapter, possible battle locations were investigated through the MCDA developed for both the Hastings and Battle areas. The MCDAs were based upon the descriptive terms used by the historical authors to describe the site as well as a number of landscape and topographic factors, including land uses, slope and a classification of the local topography (Yuan, 2010). The Hastings area model indicated that the battle was likely fought in the area around the town of Battle. The Battle area MCDA suggested the battle was possibly fought not at Battle Hill, but just to the northeast at Caulbec Hill. The section concluded that while both sites remain strong possibilities, the exact site will never be known until there is archaeological proof establishing precisely where it took place.

The chapter then moved to address research question 5, which examined the development and outcome of the battle, presenting a six stage cartographic depiction of how precisely the battle progressed. The depiction was based on estimates of army unit sizes and a subsequent time-based mapping exercise of the battle at both possible sites. In the final section of the chapter, an interpretation of the battle and landscape provided an analysis of the likely state of the battlefield that day and the factors which may have hampered the soldiers' fighting abilities, underscoring the interaction between the soldiers and the



battlefield's landscape as an important element in understanding how the battle developed.

Following the earlier discussion of the battle's geopolitical context (Chapter 4), topography of the Hastings and Battle areas (Chapter 5), the local resources (Chapter 6) and the battle itself (Chapter 7), the next chapter, will review the main finding of the study and revisit the research questions presented in Chapter 1.

## Chapter 8

### 8 Conclusion

Through a number of detailed examples and the development of novel graphical representations and maps, this study has demonstrated the importance of the natural and cultural landscape in explaining the development and outcome of the Battle of Hastings. In this conclusion, the main findings of Chapters 4 to 7 will be presented along with a detailed assessment of the extent to which the research questions posed in Chapter 1 have been addressed. The chapter also discusses several methodological considerations including the limitations of the analyses undertaken. The consideration of future pathways for research in the geographic study of historical events will be discussed as well.

#### 8.1 Chapter Summary and Research Questions

Following a broad literature review (Chapter 2) and methodological summary (Chapter 3), Chapter 4 explored the geopolitical context of the Battle of Hastings using original geographical constructs. From an economic perspective, in Chapter 4, the study produced a map of settlements in England and Normandy each presenting an aggregate value combining several factors to indicate their importance at the time. The chapter further reviewed accounts of the mobilization of the two respective armies in the battle. Interpretations of GIS-based querying confirmed the likely size of Harold and William's armies at the time of the battle. In addition, through the generation of original graphic materials, the chapter revealed that the origins of the soldiers who fought in the battle were spatially diversified. In England, the road network was shown to be an important predictor of military participation. In Normandy, the analysis indicated the main areas for service appeared to have originated from locations surrounding Bayeux and the mouth of the Seine River. In sum, the broad implication of these findings was that location greatly influenced who participated in the military campaign.

With respect to question 1, *“what can HGIS contribute to our understanding of the geopolitical state of England and northern France in the eleventh century,”* Chapter 4

provided a unique perspective to the geopolitical background at the time of the battle. This perspective allowed for an enhanced understanding of the factors that ultimately led to the battle. A series of original maps were developed by the author reflecting important geopolitical factors that to date have not been adequately addressed. Chapter 4 provided an unparalleled analysis of the factors affecting the mobilization of the English and Norman armies, revealing for the first time the role of location in determining military service in the medieval period.

Chapter 5 focused on an assessment of the degree of change occurring in the Hastings area since 1066, and specifically Hare's claim that the landscape had changed significantly since the battle (1980). It included a review of the local processes as well as a regressive examination of the local land uses, including fieldscapes, settlements and woodland. The analysis produced a series of detailed land use maps developed specifically for this study. In respect to the climate variable, both the variation in the amount of annual precipitation since the battle and the typical climate of the Hastings area were discussed and plotted in graphs. The amount of erosion was also calculated using the RUSLE model for both the Hastings and Battle areas. The analysis indicated that neither the landscape nor the slope had significantly changed since the battle, thus calling Hare's claim into question (1980).

With respect to research question 2, *"how can HGIS inform us about the natural landscape, precipitation and climate of the Hastings area and how they have changed since the battle,"* Chapter 5 made a significant contribution to the debate regarding the degree of change the Hastings region has experienced since the time of the battle. In effect, through original analysis and detailed geographic presentation, it can now be asserted with some assurance that the landscape has in fact changed relatively little over the past 1000 years. This finding is important, as it suggests that the current landscape remains an important and credible source of investigation as to the development and outcome of the battle.

Chapter 6 focused on the resources available to the English and Norman armies, including crops, iron sites, mills, salt and wood. The local population was also

investigated with regards to their spatial distribution. Based upon the local crop yield estimates and population, it was determined that both armies could have sustained themselves in the Hastings area for approximately one month.

With regard to research question 3, “*what resources (e.g. animals, food, industry, and water) were available to the English and Norman armies,*” an original assessment was undertaken in Chapter 6 of the resources likely available, potentially affecting both sides ability to wage sustained warfare in the Hastings area in October 1066. Although little can be known of what resources precisely may have been accessed by the armies prior to the battle, the study graphically provides new evidence regarding what resources were available and the accessibility of those resources.

Chapter 7 included one of the most crucial discussions of the study pertaining to the location of the battle. The chapter discussed four potential sites. Of these, the two closest in proximity to Battle were determined to be the most likely candidates based upon the historical evidence presented and the MCDA model. In addition to the location analysis, the development of the battle was progressively mapped for each one of the two prospective sites. The battlefield landscape itself was examined through factors such as the local slope, landscape classification and topographical wetness index. The examination of these factors contributed to an understanding of how the natural landscape might have impacted the outcome of the battle.

Research question 4, “*what can HGIS reveal about the potential locations of the battle and which is the most likely,*” as discussed in Chapter 7, strikes at the heart of a recently debated question within the literature with respect to the precise location of the battle. The geographic analysis undertaken here provides new evidence for the existence of no more than two credible sites in the Battle area. This acknowledges Battle, the current historical site, as one of the possible locations for the battle. Most importantly though, this study also supports the real possibility of an alternative site where the battle might have taken place.

And finally, with respect to research question 5, “*how did the natural landscape influence the development and outcome of the battle,*” Chapter 7 provides an entirely new and

unique insight into how the battle developed on that fateful day in October, 1066. With the aid of original geographic analysis, it analyzes, step by step, the actions undertaken by each army and thereby offers a critical assessment of the accounts currently available in the literature. At the end of the day, it reveals the importance of the landscape in shaping the outcome of the conflict.

## 8.2 Value of GIS in Historical Studies

This project contributes to the field of Historical GIS in several ways. As compared to the majority of GIS analysis of the ancient or medieval period (e.g. Elliott & Talbert, 2002; Lilley, Lloyd & Campbell, 2009; Lloyd & Lilley, 2009; McCormick et al., 2013), the study has provided unique and original cartographic representations and spatial analyses that far exceed that typically undertaken. The study has also contributed to the literature in specific disciplinary areas. For example, it has contributed to environmental history through its use of erosion modeling to understand the historical landscape.

Previous studies such as Cunfer (2002; 2008), Donahue (2008), Knowles et al. (2008), Novak & Gilliland (2009) or Pearson & Collier, (1998; 2002), had not considered this perspective. It forges a strong link to literary GIS through its use and analysis of specific geographic terms in historical documents. This analysis is an expansion on what has been accomplished in previous historical GIS literature (e.g. Gregory & Cooper, 2009; Lafreniere & Gilliland, 2015; Yuan, 2010). In terms of historical military GIS, the study extends current work in two important respects. One of the main contributions is the extensive analysis of a battlefield where there is a significant debate regarding its true location and little in the form of cartographic evidence. The GIS analysis undertaken in this study faces challenges not encountered by Knowles et al.'s landmark study (2008) focusing on an American Civil War battle with a known site and much cartographic and written evidence. Other similar examples are discussed by Lowe (2002). Secondly, the study goes well beyond extant research to focus on key elements of the military campaign itself, including the mobilization of and the resources available to the combatants. This new knowledge provides for a more comprehensive understanding of the conflict, further demonstrating the value of geographic research to medieval battles.

### 8.3 Challenges

There were several aspects of this project that represented significant challenges to the analysis. In Chapter 4, multiple maps were developed for Normandy which were based upon historical evidence in books and an eighteenth century map. As part of this process it was difficult to determine what elements to include and what elements not to include in the final analysis. Place name evidence was not considered as a thorough analysis would be beyond the scope of the present study.

In the case of the RUSLE model, used to determine the amount of erosion, some of the C and P values were calculated for present day industrial agricultural applications as those were the only values available. This issue was problematic as elements of the study area were not agricultural land, and thus the C and P values were less accurate. Another challenge was the land use resolution which was an integral part of the RUSLE model. The maps could have been set to a finer resolution but it would have implied greater knowledge of land uses than was present. In respect to the analysis of precipitation, the correlation between reconstructed and measured values was not as strong as would be desired.

The maps of the battle were developed by the author based upon an examination of the historical documents and then positioning military units to their approximate location in the battle. However, as is noted in this study, it was difficult to be too specific with military placements as sources were limited regarding military placements and reports were contradictory. Furthermore, with respect to the landscape, it is impossible to know the exact landscape conditions of the battle and how it might have affected the engagement throughout the day.

Finally, in setting the scene of the battle, viewsheds were examined to assist in determining which site could have been the battle site. However, these maps were only developed for one point on the map (i.e. the commander's line of sight) which was in keeping with Knowles et al.'s study on the line of site of General Lee at Gettysburg (2008). Hence, a viewshed was not calculated for the two lines of military units. While suggestive of the commander's view point and decisions, the analysis does not provide a

more refined level of viewshed analysis at the individual unit level. At the same time, to provide such an analysis would require more detailed unit placements and DEMs which would go beyond what is acceptable detail for the mapping of a medieval battle (Heinen, 1998).

## 8.4 Future Topics

There are a number of potential projects that are suggested by this study. One which could be explored is the development of a GIS database of the Norman Conquest. The database would include the documents presented above as well as others which have been widely cited in the literature. Furthermore, place name and additional historical evidence could be explored here in detail. This database would provide students of the Norman Conquest with an opportunity to spatially explore a number of questions related to the period. Subtopics could include a database of medieval Normandy which would focus on the duchy and its expansion of power in the eleventh and twelfth centuries. Another subtopic could be the spatial examination of the change in land ownership from before the Norman Conquest in 1066 until 1086.

An additional study could elaborate on the challenges discussed in Chapter 5 and examine the non-agricultural values for the RUSLE model. This research would expand the utility of the RUSLE model beyond agriculture and bring it into areas such as archaeology and urban planning. With respect to this present study, a finer resolution land use map for the Battle area over time could be developed from historical records. The data would enable the application of a finer DEM and hence more precise calculations.

Studies could also be developed to simulate the conflict with the decisions of the commanders inputted. The model could run the battle multiple times to test the probability the Normans had of winning the battle. The factors themselves could be investigated to test which variables were the most important in deciding the outcome of the battle.

## 8.5 Final Thoughts and Contributions

This study has firmly demonstrated the value of GIS to mixed-method, natural and cultural landscape based historical projects with limited sources of contemporary information. As Gregory & Ell maintain, GIS projects such as this study “shed new light on the topic by their emphasis on the geographical patterns that they find” (2007, p. 200). Furthermore, as Knowles et al. contend “geographical analysis could provide many valuable insights into military strategy, the wisdom of command decisions, and the experience of war” (2008, p. 260). As this study itself has shown, such novel interpretations of historical documents may in fact be invaluable in assisting historians to better understand the outcome of battles long debated in the literature (Gregory & Ell, 2007, p. 200). The Battle of Hastings is indeed one of those battles.

Through this study, new insights and theories regarding the Battle of Hastings were presented. The study examined the battle using the landscape as a focal point to determine a number of factors. Detailed analysis, statistical tests, and cartographic modeling were employed to evaluate a number of geographic queries pertaining to the battle. Specifically, the study addressed the landscape and how it may or may not have changed since the time of the battle. The study included a series of original detailed cartographic depictions of the battle allowing for a more comprehensive understanding of the role of the landscape in the development of the battle. Perhaps, the most intriguing finding supported by the study analysis is the very real possibility that the site of the battle may not have been at Battle Hill, as is readily accepted but at an area northeast of Battle Hill. Thus, this study has presented a new and comprehensive examination of the role of geography in interpreting and examining one of the single most important battles in British history, the Battle of Hastings.



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## Appendices

### **Appendix A: Cartographic Sources for the Norman Conquest: A Critical Review**

#### Introduction

“From the earliest maps on clay tablets to today’s in-car navigation systems, maps tell us not just where we are but who we are. They are artifacts of – and witnesses to – history.”<sup>1</sup> As true as this statement may be, most studies of one of the most important battles in European history—the Battle of Hastings and the Norman Conquest of England—have presented few maps depicting in detail England or Normandy of the time. Nor have related maps from this or other historical periods relevant to the topic typically been employed in such research.<sup>2</sup> In this paper, two distinct research foci within the literature on the Norman Conquest will be presented. The first focus relates to the depiction of medieval Normandy within the literature and how it is represented cartographically. The second focus concerns the pre-battle Norman landing site and associated land uses in eleventh century England including the battlefield itself. The study will conclude with a discussion of the assumptions and potential contribution of the various maps to current and future analysis of the Battle of Hastings and the broader Norman Conquest.

#### Cartographic Depictions of Medieval Normandy

The first of the two foci to be examined in this study concerns the range of cartographical representations that have been used in the literature to describe Medieval Normandy at the height of its power in the eleventh century. There are several maps of Medieval

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<sup>1</sup> James R. Akerman and Robert W. Karrow Jr. (Eds.) *Maps: Finding our Place in the World* (Chicago IL: The Univ. of Chicago Press, 2007): vii.

<sup>2</sup> The main exception to this trend is Darby who mapped out the Domesday Book both nationally and locally (H. C. Darby, *Domesday England* (Cambridge UK: Cambridge Univ. Press, 1977) and S. H. King, “Chapter IX Sussex,” In *The Domesday Geography of South-East England*, ed. H. C. Darby (Cambridge: Cambridge Univ. Press, 1962)).

Normandy in the many books on this subject.<sup>3</sup> A remarkable omission, however, exists in the fact that the vast majority have employed these maps in the absence of any credible discussion of their ultimate sources. These omissions are important because to accurately reflect Medieval Normandy, the modern cartographic depiction should be derived from a map of the period or as close as possible to the period in question.

In fact, there are two main criteria that are extremely useful in assessing the utility of historical cartographic sources with respect to Medieval Normandy. The initial criterion is that the map be dated prior to the French Revolution of 1789.<sup>4</sup> The Revolution was a societal break from the *Ancien Regime*— which had evolved from the middle ages and was based upon a land holding nobility and a powerful church<sup>5</sup>--to a state which was based upon the ideas of liberty, equality and French nationality.<sup>6</sup> Beyond the main goals such as abolishing the *Ancien Regime*, the revolutionaries sought “to unify France through redrawing administrative units according to uniform principles.”<sup>7</sup> Thus this outcome of the revolution implies there were possible cartographic distortions, including the introduction of new boundaries that were not in use by the administrators of the *Ancien Regime*.

The second criterion is that the map be detailed and considered accurate. According to Petto, an academic addressing eighteenth century cartography,

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<sup>3</sup> See John Le Patourel, *The Norman Empire* (Oxford: The Clarendon Press, 1976): 386-387 for the most detailed map. Bates also produced several maps in David Bates, *Normandy Before 1066* (Harlow, UK: Longman, 1982): 264-274. Richard Huscroft, *The Norman Conquest: A New Introduction* (Harlow, UK: Pearson Education Limited, 2009) reproduced another map as well from C. Harper-Bill, & E. van Houts, *A Companion to the Anglo-Norman World* (Woodbridge, UK: The Boydell Press, 2002).

<sup>4</sup> The organization of France, including its internal geographic boundaries changed after the French Revolution.

<sup>5</sup> John Merriman, *A History of Modern Europe: From the Renaissance to the Present* (2<sup>nd</sup> ed.) (New York, NY: W. M. Norton & Company, Inc., 2004): 472, 482 and 486.

<sup>6</sup> Merriman, *A History of Modern Europe*, 483-84.

<sup>7</sup> Josef W. Konvitz, *Cartography in France, 1660-1848: Science, Engineering, and Statecraft* (Chicago, IL: The Univ. of Chicago Press, 1987): 43.

the face of geography had changed. It was not enough . . . to copy older works or redraw maps from a different viewpoint; eighteenth-century geographers worked from all available sources, ancient and modern, geographical and historical, textual and graphic, printed and manuscript, and direct and indirect observations by officials, colleagues, and interested amateurs.<sup>8</sup>

The detailed maps from the eighteenth century were developed “for military planning, commerce, and governmental administration.”<sup>9</sup> One map that meets the criteria is the *Carte de Normandie* by *Guillaume Delisle* from 1716. This map (fig. 1) depicts the abbeys, bishoprics, borders and communities of Normandy at that time.<sup>10</sup> According to Petto, “Delisle . . . established a reputation for a careful and detailed method of producing maps and earned the patronage of the Orléans family as well as the crown which awarded him the singular title of first geographer of the king in 1718.”<sup>11</sup> Therefore, the maps produced by this cartographer were detailed and respectable. They were also based upon multiple sources, enhancing their reliability and thus rendering them extremely valuable to students of Medieval Normandy.<sup>12</sup>

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<sup>8</sup> Christine Marie Petto, *When France was King of Cartography: The Patronage and Production of Maps in Early Modern France* (Lanham, MD: Lexington Books, 2007): 181.

<sup>9</sup> Petto, *When France was King of Cartography*, 57.

<sup>10</sup> David Rumsey, *David Rumsey Online*, 2014, <http://www.davidrumsey.com>.

<sup>11</sup> Petto, *When France was King of Cartography*, 181.

<sup>12</sup> The main period in Medieval Norman history is from roughly the early tenth century until the early thirteenth. This period of course includes the Norman Conquest of England as well as the Norman adventures in Southern Italy, Sicily and the Crusades.

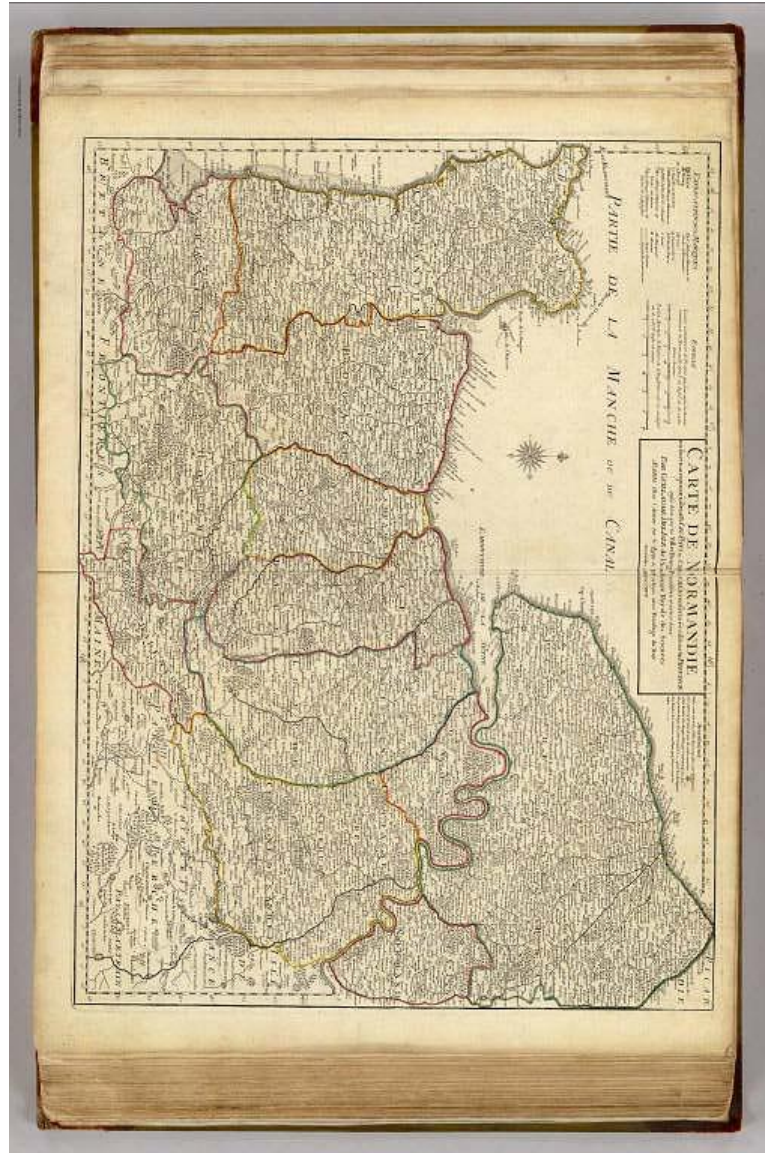


Fig 1: Delisle Map of Normandy, 1716 © David Rumsey Map Collection

Other maps of Normandy are also available, some of them considerably older. However, none have matched the level of detail of the Delisle map. One potential source is the Cassini maps of France, developed before the French Revolution<sup>13</sup> by a family of French cartographers and their associates. These maps are reasonably well detailed with woods,

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<sup>13</sup> For further information see Konvitz, *Cartography in France*, chapter 1.

roads and communities displayed.<sup>14</sup> Some of the larger centres such as Paris or Rouen even display a basic urban road network. In fact, “Louis XV . . . found Cassini’s maps so accurate that he was inspired to order a map of France made to the same level of detail.”<sup>15</sup> However, due to their detail, they are better suited to more localized studies than ones at the ducal level.<sup>16</sup> Therefore, for the purposes of examining the entire duchy, the Delisle map remains the gold standard with an exceptional level of accuracy.

The text in the Delisle map, as presented on pages 308 – 312 has been translated below from the original French including the title and an interpretation note,<sup>17</sup> the legend and symbols as well as the scale of the map. Translating these elements is crucial in interpreting the map as it helps to recognize exactly what the cartographer is emphasizing.

Map of Normandy  
 exactly marking the *Pays* or *Contrées*<sup>18</sup> enclosed in this *Province*  
 as well as the Cities, Towns, Parishes and other places.  
 By *Guillaume Delisle* of the *Academie Royale des Sciences*.  
 In Paris, among the Authors of the *Quay de l’Horloge*<sup>19</sup> with the Privilege of the King,<sup>20</sup>  
 December 1716.<sup>21</sup>

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<sup>14</sup> This map depicts the extent of woodland in the eighteenth century. To estimate the extent of wood in the eleventh, place names could be reviewed to determine which places were deforested for settlement since the eleventh century.

<sup>15</sup> Konvitz, *Cartography in France*, 22.

<sup>16</sup> M. K. Lawson, *The Battle of Hastings 1066* (Stroud, UK: Tempus Publishing Limited, 2007): Plate 49.

<sup>17</sup> According to the Collins French English Dictionary, the direct translation of *Avertis[s]ment* is warning. However, since warning has a specific connotation in English then the translation will be “interpretation note”.

<sup>18</sup> These terms are not being translated because they are key terms of the map. The term “*Pays*” is also employed by Wace as translated by van Houts (Elizabeth M. C. van Houts, “The Ship List of William the Conqueror,” *ANS X* (1987): 162). Therefore, these boundaries could potentially have been in use in at least the twelfth century. The concept of *pays* from an English perspective is discussed in Stephen Rippon, *Historic Landscape Analysis: Deciphering the Countryside* (York UK: Council for British Archaeology, 2004): 17 – 19.

<sup>19</sup> Street in Paris. *Google Inc.*

<sup>20</sup> King Louis XV succeeded to the throne in 1715.

As noted above in the map title, assuming boundaries changed slowly,<sup>22</sup> this map depicts boundaries and areas known as *pays* that were in existence in the twelfth century and were employed for administrative purposes at the time. Interpretive elements, including the interpretation note, legend and scale should also be reviewed. The map's interpretation note states:

In this Map the Episcopal Cities are distinguished from the others by a Cross in this manner (symbol) and the limits of each Diocese are marked by dashes in this manner - - - in order to distinguish them from the *Contrees* or *Pays* which are marked in this fashion .....<sup>23</sup>

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<sup>21</sup> The text of the title in French is recorded on the website where the map was obtained (Rumsey, <http://www.davidrumsey.com>). The translation of the title is by the author. The formatting of the text is from the original map.

*Carte de Normandie*  
*ou sont marquez exactement Les Pays ou Contrées enfermées dans cette Province*  
*aussi bien que les villes, bourgs, paroisses et autres lieux.*  
*Par Guillaume Delisle de l'Academie Royale des Sciences.*  
*A Paris, chez l'Auteur sur le Quay de l'Horloge avec Privilege du Roy,*  
*Decembre MDCCXVI.*

<sup>22</sup> W. G. Hoskins, *The Making of the English Landscape* (London: Hodder and Stoughton Ltd., 1977): 79.

<sup>23</sup> *Dans cette Carte les Villes Episcopales sont distinguées des autres par une Croix de cette maniere (symbol) et les limites de chaque Diocese sont marquées par des points longs de cette maniere - - - pour les distinguer des limites des Contrées ou Pays qui sont marquées ainsi .....*

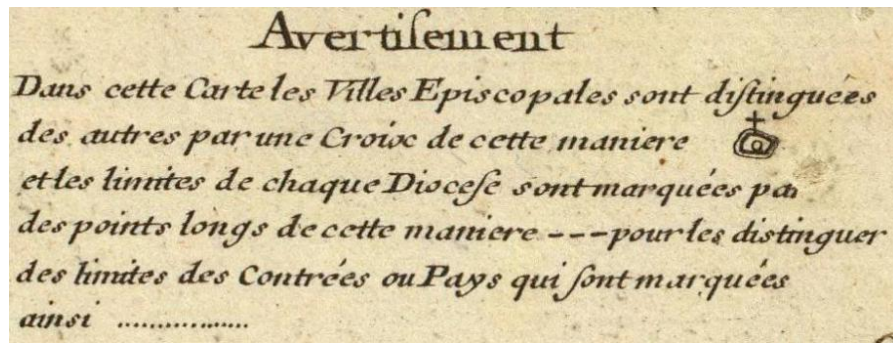


fig. 2: Interpretation Note from Delisle Map of Normandy, 1716 © David Rumsey Map Collection

The concern raised in the interpretation note regarding boundaries has to be considered when interpreting the boundaries and deciding which depict bishoprics as opposed to *pays*. Ideally though, both the bishoprics and *pays* must be considered in any thorough analysis to take into consideration the modifiable areal unit problem (see fig. 1; Chapter 3).

The second interpretive element included in the upper left hand corner of the map is the legend (fig. 3). However, the elements in the legend represent the early eighteenth century therefore, analysis to determine the degree of change since eleventh is necessary. The degree of change can be estimated with further evidence including written accounts or acts which can be examined to verify the existence of specific places in the eleventh century.



	Legend <sup>24</sup>
City	Abbey of the Order of Premontre
Town	Priory
Parish	Commandery
Church	Ducal Peerage
Abbey or Nunnery of the Order of St. Benedict <sup>25</sup>	County
Abbey of the Order of Citeaux	Marquis
Abbey of the Order of St. Augustine	Barony
	Great Road
	Roman Road

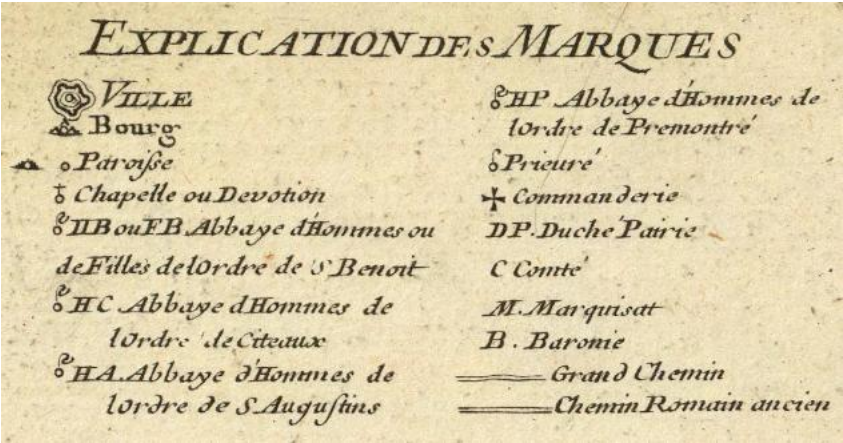


fig. 3: Mark Explanation from Delisle Map of Normandy, 1716 © David Rumsey Map Collection

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	Explication des Marques
Ville	HP Abbaye d'Hommes of l' ] Ordre de Premontre
Bourg	Priore
Paroisse	Commanderie
Chapelle ou Devotion	Duché Pairie
HB ou FB Abbaye d'Hommes ou de Filles de l' ] Ordre de S[t] Benoit	Comté
HC Abbaye d[ ] Hommes de l' ] Ordre de Citeaux	Marquisat
HA Abbaye d'Hommes de l' ] Ordre de S[t] Augustines	Baronie
	Grand Chemin
	Chemin Romain ancien

<sup>25</sup> Benedictine abbey.



The final interpretive element which is to the right of the legend is the scale of the map (fig. 4). This interpretive element presents two separate measurements. They are:

#### Scale

The Common Leagues of France are also the Common Leagues of Normandy which are 25 degrees or 2282 yards each

The Naval Leagues of France and England are 20 degrees or 2853 yards each<sup>26</sup>

There were different measurements in France at the time for the land and sea. Original scales are important to interpreting the map because, if historical documents mention a specific distance then researchers can look on the original map scales to approximate the distance, assuming similar units of distance have been used.

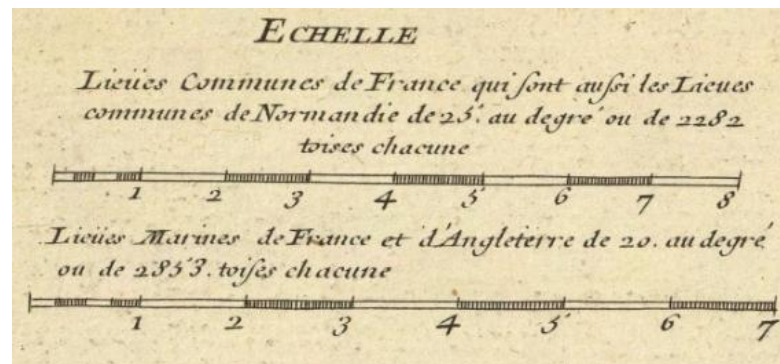


fig. 4: Scale from Delisle Map of Normandy, 1716 © David Rumsey Map Collection

<sup>26</sup> *Echelle*

*Lieuës communes de France qui sont aussi les Lieuës communes de Normandie de 25 au degré ou de 2282 toises chacune*

*Lieuës Marines de France et d'Angleterre de 20 au degré ou de 2853 toises chacune*

A discussion of the units of measurement in pre-revolutionary France is: Ronald Edward Zupko, *French Weights and Measures before the Revolution: a Dictionary of Provincial and local Units* (Bloomington: Indiana University Press, 1978). For *lieues*, Zupko, *French Weights and Measures before the Revolution*, 95-96; and *toises*, 175-76.

With respect to the map's boundaries, many follow the local rivers which contribute to their reliability as rivers acted as effective boundaries in the pre-industrial or surveyed world.<sup>27</sup>

Beyond the local boundaries, *Delisle's map* is also useful with respect to the spellings of the communities some of which are slightly different from today. For example, many communities which end in "Y" today ended in "I" in 1716. An example of this naming convention is Cerisy-la-Forêt which in 1716 was Cerisi. Some communities with hyphenated names were separate communities historically. An example of this trend is Feuguerolles-Bully which in the early eighteenth century was the two separate communities of Fugerole and Bulli. These differences reflect historical spelling's which in turn proves useful when mapping historical documents such as those of Orderic Vitalis, William of Jumièges or William of Poitiers. A final useful point is the forest distribution and road / river network which indicates wood resources as well as travel or the flow of resources in the region. Having examined the cartographic depictions of Medieval Normandy, this paper will now review cartographic material pertaining to the Norman Conquest including the landing site at Pevensey Bay.

### Mapping Pevensey Bay

A major debate pertaining to the Norman Conquest focuses on the Norman landing site. Several authors including Lawson, whose book is considered the accepted interpretation on the battle,<sup>28</sup> have reported or cartographically suggested that Pevensey Bay was potentially open water at the time.<sup>29</sup> However, currently, the most cited discussion pertaining to the landscape is Brandon (1974) who indicates Pevensey was in fact a large

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<sup>27</sup> Furthermore, Le Patourel's map was not considered because he included some borders which did not appear to follow any river. This fact would reduce the reliability of the map because the border appears to be drawn without supporting evidence. Additionally, depending on how it is drawn, some communities could be classified as in one area or another which may not be historically correct.

<sup>28</sup> Huscroft, *The Norman Conquest*, 339.

<sup>29</sup> See Fig. 132 in King, "Chapter IX Sussex," 457. Lawson, *The Battle of Hastings 1066*, 183. Lawson acknowledges that Pevensey may be a salt marsh as well (See P. F. Brandon, *The Sussex Landscape* (London: Hodder and Stroughton, 1974): 111.)

marsh.<sup>30</sup> One of the earliest cartographic depictions of this area in an academic work is by Williamson in his book on the English Channel. In this depiction, Williamson indicates that Pevensey Levels was an open bay to the sea. The map also depicts the Rye area as mostly sea as well.<sup>31</sup> This interpretation is furthered by evidence presented in King's chapter on Domesday Sussex where the alluvium and salt works were presented together for both areas, thus implying that much of Pevensey was flooded.<sup>32</sup> These interpretations are based in a large part upon an article by L. F. Salzmänn on the history of the reclamation of Pevensey. Several cartographic depictions of the area emphasize a significant bay at Pevensey.<sup>33</sup>

Another factor pertaining to Pevensey's landscape is the tidal patterns. One statistic cited is the high tide which reaches 9 to 10 feet above mean sea level.<sup>34</sup> However, there is more than just one level of high or low tide. In fact, the height of the tides varies throughout the year.<sup>35</sup> Therefore, the extent of what would be flooded would depend upon the tide and the time of year. Just as there can be no conclusive evidence indicating the area surrounding Pevensey was open water, cartographic depictions to the battle area are limited. Thus, there are spatial and temporal variations in the daily extent of the tides.

From the campaign perspective, very few historical maps are cited in the literature. Again Lawson is prominent in discussing several maps including an estate map from

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<sup>30</sup> Brandon, *The Sussex Landscape*, 111.

<sup>31</sup> James A. Williamson, *The English Channel, A History* (London, UK: Collins, 1959): 77.

<sup>32</sup> See Fig. 132 in King, "Chapter IX Sussex," 457.

<sup>33</sup> Christopher Gravett, *Hastings 1066: The Fall of Saxon England* (Oxford: Osprey Publishing, 1992): 50-1; King, "Chapter IX Sussex," 457 and Williamson, *The English Channel*, 77.

<sup>34</sup> L. F. Salzmänn, 'The Inning of Pevensey Levels', *Suss. Arch. Colls.*, 53 (1910). 32. An in-depth discussion of sedimentation in the area is beyond the scope of this paper. However, Salzmänn does make reference to accounts which mention gravel, mud and sand (See notes 51 and 64).

<sup>35</sup> E. C. F. Bird, *Coastal Geomorphology: An Introduction* (Chichester, UK: John Wiley & Sons Ltd., 2008): 26.

1724 and a mid-nineteenth century tithe map.<sup>36</sup> Lawson also includes modern topographic maps which imply the general shape of the terrain.<sup>37</sup> Another academic, Matthew Bennett, presented a nineteenth century town plan in his book on the Norman Conquest.<sup>38</sup> Nevertheless, both authors either focused on the literary elements of the maps or simply used them as illustrations thereby providing very little in the way of cartographic analysis.

This trend continues today as modern academics addressing the Norman Conquest did not reference historical maps particularly from the fourteenth to the eighteenth century despite the fact many maps of notable quality were developed. As a geographer, the author searched for historical maps which depicted the south-east coast of England to verify the representation of the 1066 landscape. Many of the located maps which depict Sussex have been well researched and presented in books or articles but were not used in interpretations of the battle. Brief discussions of the key maps pertaining to the battle are included in the following section.

The earliest map to be examined is the Gough Map. The Gough map is relevant to the Norman Conquest as it is “the earliest surviving map of Britain that shows the island in a geographically recognizable form.”<sup>39</sup> It is believed to have been developed in the fourteenth century but some authors place its date in the late thirteenth century.<sup>40</sup> The Gough map is considered because it does display the area of East Sussex where the

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<sup>36</sup> Lawson, *The Battle of Hastings 1066*, 52-58. East Sussex Record Office BAT 4421, Nos. 6/7 and TD/E 158 (hereafter ESRO).

<sup>37</sup> Lawson, *The Battle of Hastings 1066*, 139 and 143-45. The detailed contour map is presented in R. Allen Brown, ‘The Battle of Hastings’, *ANS* III (1980).

<sup>38</sup> Matthew Bennett, *Campaigns of the Norman Conquest* (Oxford, UK: Osprey Publishing Ltd., 2001): 86-87.

<sup>39</sup> K. D. Lilley, C. D. Lloyd & B. M. S. Campbell, “Mapping the Realm: A New Look at the Gough Map of Britain (c.1360),” *Imago Mundi* 61(1) (2009): 1-28; C. D. Lloyd & K. D. Lilley, “Cartographic Veracity in Medieval Mapping: Analyzing Geographic Variation in the Gough Map of Great Britain,” *Annals of the Association of American Geographers* (2009): 29.

<sup>40</sup> Lilley, Lloyd & Campbell, “Mapping the Realm”, 1-28; Lloyd & Lilley, “Cartographic Veracity in Medieval Mapping”, 29.

Norman Conquest began in 1066 with a reasonable degree of accuracy as indicated by an  $R^2$  value of at least 0.75 for a geographically weighted regression model.<sup>41</sup> Therefore, we can discern a rough approximation of how the landscape appeared in the eleventh century. The section of this map relevant to this study is displayed in fig. 5 below.<sup>42</sup> However, interestingly enough, this map does not display a bay around Pevensey.<sup>43</sup> This finding is in stark contrast to what some authors, as mentioned earlier have suggested existed at the time. Therefore, either the bay was filled in by this time or modern depictions need revision.



fig. 5: Section of Gough Map centered on East Sussex (Fourteenth Century) © Bodleian Library, MS. Gough Gen. Top. 16.

Over two-hundred years later, there are two late sixteenth century maps which depict the south coast around the time of the Spanish Armada (1588).<sup>44</sup> The first map is entitled:

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<sup>41</sup> See Figure 12 in Lloyd & Lilley, “Cartographic Veracity in Medieval Mapping”, 41-44.

<sup>42</sup> Oxford, *Bodleian Library*, MS. Gough Gen. Top. 16 (hereafter *Bodleian*).

<sup>43</sup> Some have commented that the coastline is highly approximate and cannot be considered as accurate. However, the fact that the cartographer drew Rye in detail and not Pevensey is evidence in itself that there was no open water in that area, although given its date and scale, the validity of the map could not be verified.

<sup>44</sup> The armada was an attempted invasion of England by the Spanish in 1588. There were subsequent attempts by the Spanish in the 1590s but all failed. *BL*, <http://www.bl.uk/onlinegallery/index.html>.



The second Armada map was reproduced in 1870 along with an interpretation of the written text by Mark Antony Lower. The study is titled: *A Survey of the Coast of Sussex, made in 1587, with a view to its defence against Foreign Invasion, and especially against the Spanish Armada*.<sup>46</sup> Here the Pevensey area is presented as a series of channels in conjunction with salt marsh and beach.<sup>47</sup> The written text confirms this presentation by indicating “the marshes, castle, and haven of Pevensey.”<sup>48</sup> Thus, again as indicated above, the Pevensey area was not open water.

If we assume that the previous authors are correct and there was an extensive bay at Pevensey, then based upon the cartographic evidence above, by the mid-fourteenth century, all of the human reclamation and depositional processes would have been completed. However, considering the estimated size of the bay, the rates of natural processes<sup>49</sup> and the pre-nineteenth century human ability to alter the landscape, then if Pevensey was in fact an extensive bay in 1066, it would have taken far longer for sediment to deposit and build up.<sup>50</sup> Therefore, the suggestion that Pevensey was an extensive open bay in 1066 is called into question.

The Yeakell and Gardner (Y & G) map (fig. 7) depicts the fields of Sussex in the late eighteenth century at the time of parliamentary enclosure and at the beginning of the

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<sup>46</sup> Mark Antony Lower, *A Survey of the Coast of Sussex, made in 1587, with a view to its defence against Foreign Invasion, and especially against the Spanish Armada* surveyed by T. Palmer and W. Covert (Lewis, UK: Sussex Agricultural Express, 1870). The manuscript is BL, Add MS 57494 f. 13.

<sup>47</sup> BL, Add MS 57494 f. 13.

<sup>48</sup> Lower, *A Survey of the Coast of Sussex*, 6 or BL, Add MS 57494 f. 13.

<sup>49</sup> R. B. G. Williams and D. A. Robinson, “The Landforms of Sussex,” in *Sussex: Environment, Landscape & Society*, ed. The Geography Editorial Committee (Gloucester, UK: Alan Sutton Publishing Limited, 1983): 45-47. For a review of coastal processes, see Chapter 2 in Bird, *Coastal Geomorphology*.

<sup>50</sup> This point reinforces Brandon’s and insinuates that probably there would have been more firm ground than thought by the eleventh century. (Brandon, *The Sussex Landscape*, 111).

industrial revolution.<sup>51</sup> A previous study has indicated that the “boundaries on this map are intended to represent actual field boundaries”.<sup>52</sup> The local road network is also depicted in detail. This map is relevant in examining the Norman Conquest for several reasons. The road network is important because “[f]ew new roads were created between Saxon times and the turnpike and ‘enclosure’ roads of the eighteen century”.<sup>53</sup> Therefore, the local medieval road or simple track network could be derived from this map. However, in addition to the road network, the field boundaries would have to be examined to see when they appeared as they may not have existed in the eleventh century.

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<sup>51</sup> *An Actual Survey of the County Of Sussex by T Yeakell and W Gardner 1778-1883*, Map of Sussex, 2inch to 1 mile. Sheets 1 - 4. West Sussex Record Office, 3 Orchard Street, Chichester, West Sussex PO19 1DD, United Kingdom. Available online from: Dominic Fontana, *Old Sussex Mapped: Two Centuries of Sussex County Maps*, 2000, <http://www.envf.port.ac.uk/geo/research/historical/webmap/sussexmap/sussex.html>; Christopher Taylor, *Fields in the English Landscape* (Stroud, UK: Sutton Publishing Limited, 2000), 139-40.

<sup>52</sup> Kingsley, *Printed Maps of Sussex*, 92.

<sup>53</sup> Hoskins, *The Making of the English Landscape*, 242. These additions to the road network could be considered when developing a local medieval road network.



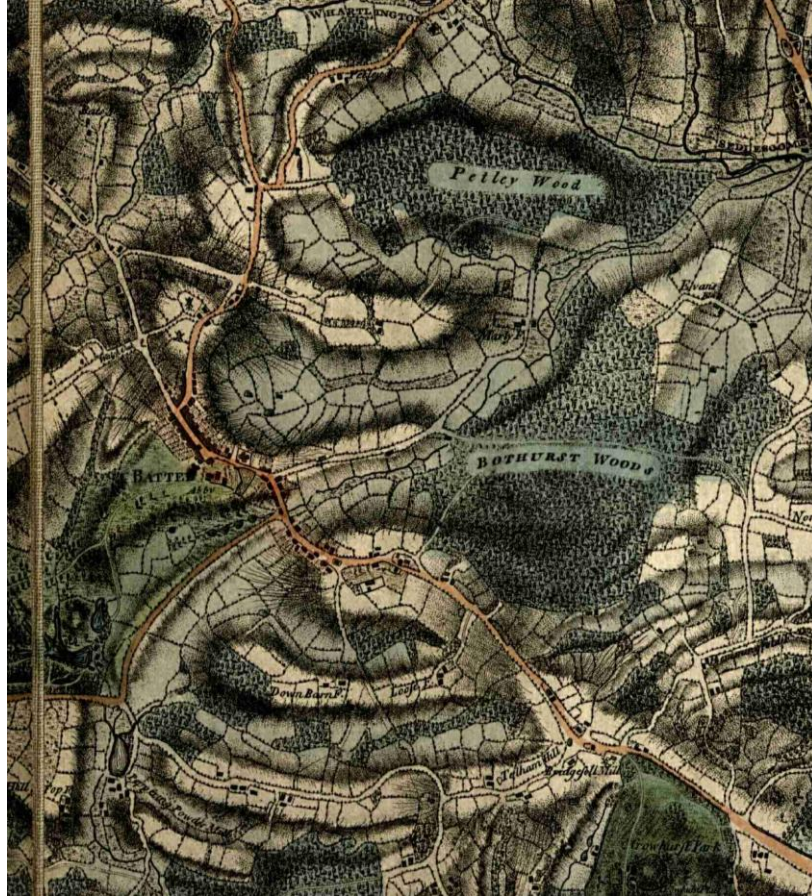


fig. 7: Section of Yeakell & Gardner Map centered on Battle (1783) © West Sussex Record Office.

In summarizing cartographic depictions of the Hastings area, this depiction of Pevensey as a bay is called into question as no relevant maps indicate a large bay at that location. The geographic examination of the coastal areas and the Pevensey area can provide a number of clues to the landscape which may have existed during the Norman Conquest. It is important to understand the landscape that the Normans encountered when they arrived and the resources available to them as well as any routes or existing road networks.<sup>54</sup> As much of the Romney area has been studied, the central discussion point for this section is: could Pevensey Bay have gone from an open bay during the time of

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<sup>54</sup> These questions are beyond the scope of this paper but should be considered in future research.

the Norman Conquest to an inland marsh in the mid-fourteenth century when the Gough map was drawn?<sup>55</sup> The present author disagrees and hypothesizes that Pevensey Bay was a transitional landscape with primarily tidal marshland and several fluvial channels which would have carried the tide further inland to where it was recorded in Domesday. During some high tides, large tracks of the marshland would have been periodically flooded.<sup>56</sup> This landscape is alluded to in the Armada map from 1587 as well as in the Speed and Morden maps of Sussex from the seventeenth century.<sup>57</sup> Therefore, it is this landscape which should be depicted and assessed in the studies of the Norman Conquest.

Furthermore, this new interpretation of the landscape does not alter the theory that William landed at Pevensey. Based upon an interpretation of the local tides, the high tide typically would occur 3 days after the Full Moon.<sup>58</sup> It has been calculated that the moon was in its first quarter around September 28, 1066.<sup>59</sup> This indicates that the high tides when William would have landed would have been lower. However, they still would have been high enough that William was able to beach his ships in the extensive marshland or along the many channels which would have likely extended through the area. During the low tide, William might have moved part of his army across the levels. This interpretation of William's landing is illustrated to in the *Bayeux Tapestry* as horses

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<sup>55</sup> Bodleian, MS. Gough Gen. Top. 16.

<sup>56</sup> Brandon, *The Sussex Landscape*, 111.

<sup>57</sup> Lower, *A Survey of the Coast of Sussex* and Speed and Morden's maps online at: Fontana, Old Sussex Mapped, <http://www.envf.port.ac.uk/geo/research/historical/webmap/sussexmap/sussex.html>.

<sup>58</sup> The first two websites provide information on current tides in the Hastings area. Lunar Calendar, Moon Phases and Space Weather, "Moon phase for 12 July 2014 Saturday", 2014, <http://lunaf.com/english/moon-phases/lunar-calendar-2014/07/12/>; Hastings Borough Council, "Tide Tables for Hastings", 2014, [http://www.hastings.gov.uk/community\\_living/tide\\_tables/](http://www.hastings.gov.uk/community_living/tide_tables/). The final website presents the phases of the moon back in the eleventh century. National Aeronautics and Space Administration, "Phases of the Moon: 1001 to 1100", 2007, <http://eclipse.gsfc.nasa.gov/phase/phases1001.html>.

<sup>59</sup> J Neumann, 'Hydrographic and Ship-Hydrodynamic Aspects of the Norman Invasion, AD 1066', *ANS* XI (1988): 224.

are displayed being unloaded from ships into the water and then ridden off to the shore.<sup>60</sup> This theory is only possible though if the landing site was on reasonably firm ground as opposed to looser ground or mud where movement of a large body of men and horses would prove more difficult. As discussed above, if the area was flooded only periodically throughout the year, the land then would have been firmer which would have allowed transportation through the marsh. Furthermore, as Salzmann has indicated, mud and sand did exist in the Pevensey area.<sup>61</sup> Additionally the ships might have been utilized as make-shift bridges through flooded areas. Thus, the possibility exists that William moved part of his army across the marsh.

In regards to the Sussex area, the most detailed map discussed is the Y & G map. Unlike the 1724 estate map of Battle, this map does depict land use and topography. This map is relevant in analyzing the battle area as land use and topography are useful tools in the geographical analysis of the area.

### Discussion

There are two important assumptions pertaining to the maps discussed in this paper. The first assumption is that the boundaries have not changed significantly between the time of the battle and the dates of the maps discussed in this paper. In fact, in England, despite periodic political turmoil, the local shire boundaries dating back to the medieval period were in use up until a rearrangement in 1974.<sup>62</sup> While, there was a degree of political

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<sup>60</sup> Frank M. Stenton, (1965). *The Bayeux Tapestry: A Comprehensive Survey* (2nd ed.) (London: Phaidon Press, 1965): Plates 45, 46.

<sup>61</sup> Salzmann, 'The Inning of Pevensey Levels'. For further information on soils see: Cranfield University, "LandIS - Land Information System - National Soil Map - NATMAP Soilscales", 2012, from <http://www.landis.org.uk/data/nmsoilscales.cfm> and Nyle C. Brady, and Ray R. Weil, *Elements of the Nature and Properties of Soils* (2nd ed.). (Upper Saddle River, NJ: Pearson Education, Inc, 2004).

<sup>62</sup> Historic Counties Trust, "The Historic County Borders Project," 2010, <http://www.county-borders.co.uk/>.

flux in the region through the eleventh to fifteenth centuries,<sup>63</sup> Delisle's map of Normandy provides a depiction of the duchy in the eleventh century.

At a more local level, specifically with respect to Sussex, it has been stated that it was an "immeasurably slow process by which the English landscape, down to the nineteenth century, came into being".<sup>64</sup> Generalizing beyond this statement, it is assumed the local boundaries are generally applicable to earlier periods. However, with over 700 years of deforestation, enclosures and land reclamation, there are areas whose land use is certainly different from that of the Middle Ages. This fact adds a further level of difficulty to analyzing the medieval landscape. These difficulties are discussed by Harvey who indicates "[m]apping the medieval village may be a valuable exercise . . . [but] would be unwise to place great confidence in the result."<sup>65</sup> Thus, despite the wide range of evidence which would support these maps, there are some uncertainties which must be acknowledged.

### Conclusion

There are many research opportunities which can be explored with the maps presented in this paper. Many of these avenues are beyond the scope of this paper and require the use of a geographic information system (GIS).<sup>66</sup> With respect to Medieval Normandy, a GIS database including the major towns, abbeys, castles and the political boundaries, individual rivers and roads is such a project. A study of place names would be useful here as well. This data furthers our knowledge because by digitizing the roads and rivers in conjunction with major centres in the medieval period we can then gain a spatial

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<sup>63</sup> Elizabeth M. Hallam, *Capetian France, 987-1328* (London, UK: Longman Group Limited, 1980) provides a good overview of France from the eleventh to the early fourteenth century.

<sup>64</sup> Hoskins, *The Making of the English Landscape*, 79.

<sup>65</sup> P. D. A. Harvey, "Mapping the Village: the Historical Evidence" in *Medieval Villages*, ed. D. Hooke, (Oxford, UK: 1985).

<sup>66</sup> A GIS is a "[c]omputer-based system to aid in the collection, maintenance, storage, analysis, output, and distribution of spatial data and information" (See Paul Bolstad, *GIS Fundamentals: A First Text on Geographic Information Systems* (2 ed.). White Bear Lake, MN: Elder Press, 2005): 1.)

perspective on the local trade network. The trade network can also be considered at the regional level as defined by the internal boundaries. Furthermore, as Delisle developed maps for other parts of France as well, similar analyses (data permitting) can be conducted for those regions. Thus, researchers will be able to develop detailed maps of a number of duchies.

In considering Sussex, land use maps can be developed from historical maps in conjunction with additional sources. The maps would not only provide an estimation of the land uses as they were at the time of the Norman Conquest, but also throughout history since the eleventh century. This analysis allows us to determine a frame work by which general changes to the landscape can be explored. In considering land use in 1066, one argument which has been raised albeit briefly is the resources available to William at the time of the battle.<sup>67</sup> However, a GIS land use database allows for an estimate of the yields of multiple resources.

In conclusion, this paper has indicated how relevant historical maps can be in studying periods from which there were no maps. For Normandy, there is an eighteenth-century map by Guillaume Delisle which depicts the *pays* in addition to the forests, roads, rivers and communities as they potentially existed at that time. With this map, researchers are provided with not only a new perspective of the borders and potential resources in medieval Normandy but the extent of trade as well. Conversely, in Sussex, and the Battle region, the detailed land uses of the late eighteenth century, in combination with information from earlier maps, provide valuable information as to how the landscape appeared in the eleventh century. Therefore, researchers gain not only an idea of how the landscape appeared but also what resources were available and in what approximate quantities. Thus, historical maps such as those reviewed in this study do provide excellent insight into the geographic details as they pertain to the Norman Conquest and the Battle of Hastings.

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<sup>67</sup> Stephen Morillo, *Warfare Under the Anglo-Norman Kings, 1066-1135* (Woodbridge, UK: The Boydell Press, 1994): 126-27.

## Appendix B: Glossary

Cartography - “the art, science, or technology of drawing or compiling maps and charts” (Allen, 2002, p. 126).

Climograph - “plot[s] daily, monthly or annual temperature and precipitation values for a selected station; may also include additional weather information” (Christopherson, 2004, p. 555)

Coding - “the process of associating words or labels with passages and then collecting similarly labeled passages into files” (Adler & Clark, 2003, p. 503).

*Conroi* - “the basic fighting unit . . . [of mailed knights] usually of some multiple of ten men” (Chibnall, 1996, p. 81).

Digital Elevation Model (DEM) - “a sample of elevations or depths taken on a regular grid” (Kimerling, Buckley, Muehrcke, & Muehrcke, 2009, p. 444).

Discharge - a volume of water draining past a certain point and measured in cubic meters per second (Dingman, 2008, p. 19).

Drainage Basin – “an area within which water supplied by precipitation is transferred to the ocean, a focus of internal drainage, such as a lake, or to a larger stream” (Summerfield, 1991, p. 207).

Drainage Divide – “The surface trace of the boundary that delimits a [drainage basin]” (Dingman, 2008, p. 10).

*Familia Regis* - “was the military system, for the influence of its members, if not its actual structure, reached into every aspect of the Anglo-Norman military machine” (Morillo, 1994, pp. 60-1).

Feudalism - “a personal bond between two free men – a superior (the lord) and an inferior (the vassal) – and a method of land tenure, whereby the vassal held a benefice of his lord” (Barlow, 1988, p. 7).

Field Capacity – “The percentage of water remaining in a soil 2 or 3 days after its having been saturated and after free drainage has practically ceased” (Brady & Weil, 2004, p. 575).

*Fyrd* - “existed partly on the basis of a territorial obligation – one man owed from every five hides of land – which was organized for the support of these soldiers” (Morillo, 1994, p. 48)

Geographic Information Science (GISci) - “theoretical foundation on which GIS . . . [is] based” (Bolstad, 2005, p. 13)

Geographic Information System (GIS) - “[c]omputer-based system to aid in the collection, maintenance, storage, analysis, output, and distribution of spatial data and information” (Bolstad, 2005, p. 1)

Geography - “a science that deals with the earth and its life; *esp* the description of land, sea, air, and the distribution of plant and animal life including human beings and their industries” (Allen, 2002, p. 367)

Geomorphology - “the scientific study of the morphology of the surface of the Earth and the processes operating on it, in the present, the past, and the future” (Trenhaile, 2010, p. 1)

Grounded Theory - “theory derived from data in the course of a particular study” (Adler & Clark, 2003, p. 335)

Grounded Visualization - “adopting two analytical methods – grounded theory (based in qualitative research) and visualization (based on quantitative GIS)” (Knigge & Cope, 2006, p. 2024)

*Hauberk* - “a shirt of chain mail . . . supplied not by the . . . [lord] but by the . . . [vassal] in twelfth century warfare” (Morillo, 1994, p. 79)

Hide - “probably originated as an amount of land needed to support a peasant family for a period of one year and, at the same time, as a unit of tax assessments. But, beginning in

the eleventh century, the hide was usually expressed in terms of acres, with . . . [between 60 and 180] acres being the most common” (Zupko, 1968, p. 76).

Housecarls - “household troops [linked to] various forms of the old Germanic . . . institution of warriors . . . skilled in their craft and intensely loyal to their lord” (Hollister, 1962, p. 9)

Hundred - “a neat administration, in which each Hundred contained 100 hides and each hide a hundred acres” (DB Sussex, 1976).

Hydrograph - “A graph of stream discharge over a period of time (minutes, hours, days, years) at specific place on a stream. The relationship between stream discharge and precipitation input is illustrated on the graph” (Christopherson, 2004, p. 561)

Hydrologic / Water Cycle - “the movement of water substance on and under the earth’s land surfaces, the physical and chemical interactions with earth materials accompanying that movement, and the biological processes that conduct or affect that movement” (Dingman, 2008, p. 1)

Hydrology - “the geosciences that describes and predicts the occurrence, circulation, and distribution of the water of the earth and its atmosphere” (Dingman, 2008, p. 1)

Mass Movement - “downslope movement of rock and soil in response to gravity” (Trenhaile, 2010, p. 130)

Meadow - “land bordering a stream liable to flood, producing hay, and afterwards used for grazing . . . [It] was [also] of great value” (Darby, 1977, p. 137).

*Miles* - “used in England throughout the eleventh and into the early twelfth century, covering [all] footsoldiers and horsemen . . . unless modified by . . . some other term” (Morillo, 1994, p. 11)

Open-Fields - “each village was surrounded by two of three large open and unhedged fields, divided into a multitude of strips, all individually owned but farmed in common” (Taylor, 2000, p. 71)



*Pagus* - Carolingian administrative district controlled by a *vicomte* (Huscroft, 2009, p. 38)

Pasture - “land available for grazing all the year round” (Darby, 1977, p. 137)

Raster - “a regular set of cells in a grid pattern . . . [which are typically] square and evenly spaced in the x and y directions” (Bolstad, 2005, p. 40)

Shire - “all of England, with the exception of . . . [certain areas] was divided into [administrative areas called] shires, each under the control of a ‘shire-reeve’ or ‘sheriff’” (Huscroft, 2009, pp. 31-2)

Spatial Autocorrelation - the “fact that data from locations near one another in space are more likely to be similar than data from locations remote from one another” (O'Sullivan & Unwin, 2010, p. 34)

Tides - “movements of the oceans set up by the gravitational effects of the moon and the sun in relation to the earth” (Bird, 2008, p. 25)

Vector - “uses sets of coordinates and associated attribute data to define discrete objects . . . [which are] points, lines, and polygons” (Bolstad, 2005, p. 33)

Wetland - “have the presence of shallow water or flooded soils for part of the growing season, have organisms adapted to this wet environment, and have soil indicators of this flooding such as hydric soils” (Mitsch & Gosselink, 2007, p. 524)

Wilting Point – “The moisture content of soil, on an oven-dry basis, at which plants wilt and fail to recover their turgidity when placed in a dark, humid atmosphere” (Brady & Weil, 2004, p. 591).

Woodland - a natural area mainly covered in trees (Rackham, 1980, p. xvii)

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